

TECHNICAL SPECIFICATION SECTION-SWITCHYARD ERECTION



पावरग्रिड

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(भारत सरकार का उद्यम)

Power Grid Corporation of India Limited

(A Government of India Enterprises)

TECHNICAL SPECIFICATION

**SECTION- SWITCHYARD ERECTION
REVISION - 10**

SECTION-(SE)
SWITCHYARD ERECTION

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1.0 GENERAL

This section covers erection of all equipment such as circuit breakers, isolators, current transformers, voltage transformers, surge arresters etc. This section also covers design, engineering, manufacture, testing at works, supply, insurance, handling, storage, erection, testing and commissioning of supply & erection of following items.

- String insulators and hardware
- AAC / ACSR conductor
- Galvanised Steel Earthwire
- Aluminium Tube
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

2.0 String Insulators & Hardware

The insulators for suspension and tension strings shall conform to IEC-60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486. Composite long rod polymer insulator shall conform to IEC:61109. Further, the contractor shall supply insulators as per details mentioned below:

A. Tension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations in coastal, pollution affected areas as identified in Section-Project and for all substations in Northern Region)	Composite Long Rod Polymer with 31mm/kV Creepage
2.	765kV, 400kV, 220kV & 132kV (for substations not covered in 1. above)	Composite Long Rod Polymer/Porcelain/Glass with 31mm/kV Creepage

B. Suspension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations)	Composite Long Rod Polymer with 31mm/kV Creepage

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2.1 Construction Features (Porcelain & Glass Insulators)

2.1.1 Porcelain insulators

- a) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength, manufacturer's logo, month & year of manufacturing markings on porcelain printed and applied before firing.
- b) Porcelain used in insulator manufacturing shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- c) Glazing of the porcelain shall be of uniform brown colour, free from blisters, burrs and other similar defects.

2.1.2 Glass insulators

It **shall** be made of toughened glass. Glass used for the shells shall be sound, free from defects, flows bubbles, inclusions, etc and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.

2.1.2.1 When operating at normal rated voltage, there shall be no electric discharge between conductor and insulator which would cause corrosion or **damage** to conductors or insulators by the formation of substances due to chemical action.

2.1.2.2 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS-209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

2.1.2.3 Contractor shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

2.1.3 Hardware Fittings

2.1.3.1 Clamps for insulator strings and Corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.

2.1.3.2 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

2.1.3.3 The tension Insulator hardware assembly shall be designed for minimum 21000 kg tensile load for 765kV and minimum 12000 kg tensile load for hardware

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assembly below 765kV. Earth wire tension clamp shall be designed for minimum 1000 kg tensile load with a factor of safety of two (2).

2.1.3.4 The tension string assemblies shall be supplied alongwith suitable turn buckle. Sag compensation springs if required may also be provided.

2.1.3.5 All hardware shall be bolted type.

2.2 Tests

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

2.2.1 Type Tests on Insulator Strings: The test reports for following type tests shall be submitted for approval as per clause 9.0 of Section - GTR.

- a) Power frequency voltage withstand test with corona control rings (**if applicable**) under wet condition as per IEC- 60383.
- b) Switching surge voltage withstand test [400 kV and above class only] under wet condition as per IEC-60383.
- c) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383
- d) Voltage distribution test (Dry) [**applicable for disc insulator string only**]

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 6.5% for 765 kV suspension and tension insulator strings, 9% and 10% for 400KV suspension string and tension insulator string respectively, 13% for 220KV suspension and tension insulator strings, 20% and 22% for 132KV suspension and tension insulator strings respectively.

- e) Corona Extinction Voltage test (Dry) [**220kV** and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage **as specified at clause 2.3.2**. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

- f) RIV Test (Dry) [**220kV** and above class only]

Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage as **specified in clause 2.3.2 of this section**. The test procedure shall be in accordance with IS 8263/IEC 60437.

- g) Mechanical strength test: The test shall be carried out as per following procedure.

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The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.2.2 Type Tests on String Insulator Units

Type test report for Thermal Mechanical Performance tests (**applicable for porcelain type insulators**) as per IEC-60575, Clause 3 shall be submitted for approval as per clause 9.2 of Section - GTR.

2.2.3 Acceptance Tests for Insulators:

- a) Visual examination as per IEC-60383/ IEC-61109 clause no. 7.2 (for composite long rod insulators).
- b) Verification of Dimensions as per IEC- 60383.
- c) Temperature cycle test as per IEC- 60383.
- d) Puncture Test as per IEC-60383 (Applicable only for porcelain insulators).
- e) Galvanizing Test as per IEC- 60383.
- f) Mechanical performance test as per IEC-60575 Cl. 4 / IEC-61109 clause no. 7.2 (for composite long rod insulators).
- g) Test on locking device for ball and socket coupling as per IEC-60372(2).
- h) Porosity test as per IEC- 60383 (Applicable only for porcelain insulators).
- i) Thermal shock test as per IEC-60383 (Applicable only for glass insulators)

2.2.4 Acceptance Test on Hardware Fitting

- a) Visual Examination as per Cl. 5.10 of IS: 2486 (Part-I).
- b) Verification of Dimensions as per Cl. 5.8 of IS:2486 (Part-I)
- c) Galvanising/Electroplating tests as per Cl. 5.9 of IS:2486 (Part-I).
- d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)
- e) Shore hardness test **by** the Elastometer

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- f) Mechanical strength test for each component (including corona control rings and arcing horns).

The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 2.2.1.(g) above should be followed.

- g) Test on locking devices for ball and socket coupling as per IEC -60372(2).

2.2.5 Routine Test on Insulator

- a) Visual Inspection as per IEC-60383
b) Mechanical Routine Test as per IEC-60383
c) Electrical Routine Test as per IEC-60383

2.2.6 Routine Test on hardware Fittings

- a) Visual examination as per Cl 5.10 of IS:2486 (Part-I)
b) Mechanical strength Test as per Cl. 5.11 of IS:2486 (Part-I)

2.2.7 Test during manufacture on all Components as applicable on insulator

- a) Chemical analysis of zinc used for galvanising: Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209. The purity of zinc shall not be less than 99.95%.
b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:

The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Program.

2.2.8 Test during manufacture on all components as applicable on hardware fittings:

- a) Chemical analysis of zinc used for galvanising:
Samples taken from the zinc ingot shall be chemically analyzed as per IS:209. The purity of zinc shall not be less than 99.95%
b) Chemical analysis, hardness tests and magnetic particle for Forgings/
fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for forgings/fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

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2.3 Guaranteed technical Particular For

2.3.1 Disc Insulators

Sl. No.	Description	For 765kV	For 400/220/132kV
a)	Type of insulators	Anti Fog type	Anti Fog type
b)	Physical Size of insulator units		
(i)	Diameter of Disc	As per IEC	As per IEC
(ii)	Ball to ball spacing between discs	170 mm	145 mm
c)	Electro mechanical strength	210 kN	120 kN
d)	Minimum Creepage distance of individual insulator units	460 mm	430 mm
e)	Markings		
i)	For Porcelain insulators	Markings on porcelain	Markings on porcelain
ii)	For toughened glass insulators	Markings shall be done on initial parts	Markings shall be done on initial parts
f)	Power frequency puncture withstand voltage	1.3 times the actual wet flashover voltage	1.3 times the actual wet flashover voltage

2.3.2 INSULATOR STRING

Sl. No.	Description	765 kV	400kV	220kV	132kV
a)	Power frequency withstand voltage of the complete string with corona control ring (wet) – KV rms	870	680	460	275
b)	Lightning impulse withstand Voltage of string with corona control rings (dry) - kVp	± 2100	± 1550	± 1050	± 650
c)	Switching surge withstand voltage of string with corona control rings (wet) - kVp	± 1550	± 1050	NA	NA
d)	Minimum corona extinction voltage level of string with Corona Control rings (dry) - kV rms	508	320	156	NA
e)	Maximum RIV level in micro volts of string with Corona Control rings across 300 Ohms resistor at 1 MHz	1000 (Max) at 508 kV	1000 (Max) at 320 kV	1000 (Max) at 156 kV	NA
f)	Minimum total creepage distance of the insulator string (mm)	24800	13020	7595	4495
g)	Minimum no. of discs per string (for tension string if applicable)	54	31	18	11

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h)	Electromechanical strength of Insulator Unit. (KN)	210	120	120	120
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For tension application:-

Double insulator strings for 765kV, 400kV, 220kV and single insulator strings for 132 kV systems shall be used.

For suspension application:-

V-type polymer insulator string shall be used for 765kV system and single suspension polymer insulator string shall be used for 400kV, 220kV & 132 kV systems.

2.4 COMPOSITE LONG ROD POLYMER INSULATOR

Bidder shall offer composite long rod polymer insulators with suitable hardware fittings.

2.4.1 Details of Composite Long Rod Insulators

2.4.1.1 Insulators shall have sheds of the “open aerodynamic profile without any under ribs” with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

2.4.1.2 Ball and socket shall be 20mm designation for 120kN & 24mm designation for 210kN Insulators in accordance with the standard dimensions stated in IEC:60120/ IS:2486 (Part-II). Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have laser markings on housings for manufacturer’s name, month & year of manufacturing, rated strength markings on each composite insulator rod unit. No negative tolerance shall be applicable to creepage distance of composite insulators

2.4.1.3 **All ferrous parts shall be hot dip galvanized as per Section-GTR with minimum weight of zinc coating as 610 gm/sq.m for normal area and 900 gm/sq.m for coastal area as specified in Section-Project.**

2.4.2 Material

2.4.2.1 Core

It shall be a glass-fiber reinforced (FRP) epoxy resin rod of high strength. The rod shall be resistant to hydrolysis. The rod shall be of electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

2.4.2.2 Housing & Weathersheds

The FRP rod shall be covered by a sheath of a silicone rubber compound of a thickness of minimum **5mm**. The housing & weathersheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-

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destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core.

The weathersheds of the insulators shall be of alternate shed profile. The weathersheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

2.4.2.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron/ spheroidal graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The sealing shall stick to both housing and metal end fitting. The sealing must be humidity proof and durable with time.

End fittings shall have suitable provisions for fixing grading rings at the correct position as per design requirements.

2.4.2.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The insulator supplier shall furnish design calculations using appropriate electric field software showing electric field at surface of housing, inside housing & core and at the interface of housing and metal fittings with the proposed placement and design of corona **rings**. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The design & supply of grading rings shall be in the scope of the composite insulator supplier.

2.4.3 Tests

2.4.3.1 Type Tests

The test reports for following type tests on long rod units, components, materials or complete strings shall be submitted for approval as per clause 9.2 of Section - GTR.

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2.4.3.1.1 On the complete composite Long Rod Polymer Insulator String with Hardware Fittings:-

- a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns (if provided) under wet condition as per IEC:60383-1993.
- b) Switching surge voltage withstand test under wet condition as per IEC:60383-1993.
- c) Impulse voltage withstand test under dry condition as per IEC:60383-1993
- d) Corona and RIV test under dry condition. [132kV and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage as specified in clause 2.3.2 of this section There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

Under the conditions as specified above the insulator string alongwith complete hardware fittings shall have a radio interference voltage level as specified at specified in clause 2.3.2 of this section. The test procedure shall be in accordance with IS 8263/IEC-60437.

- e) Mechanical Strength test: The test shall be carried out as per following procedure.

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

- f) Salt-fog pollution withstand test as per IEC: 60507. The salinity level for composite long rod insulators shall be 160 Kg/m³ NaCl.

2.4.3.1.2 On Composite Polymer Insulator Units

- a) Tests on interfaces and connections of metal fittings as per IEC: 61109-2008.
- b) Assembled core load time test as per IEC: 61109-2008.
- c) Damage limit proof test and test of tightness of interface between end firings and insulator housing as per IEC: 61109-2008
- d) High Pressure washing test

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The washing of a complete insulator of each E&M rating is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, the washing shall be carried out for 10minutes. There shall be no damage to the sheath or metal fitting to housing interface. The verification shall be done by 1 minute wet power frequency withstand test at 680kV r.m.s for 400KV.

e) Brittle fracture resistance test

The test arrangement shall be according to Damage limit proof test with simultaneous application of 1N-HNO₃ acid directly in contact with naked FRP rod. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm. The rod shall withstand 80% of SML for 96 hours.

f) Dye penetration test as per IEC: 61109-2008

g) Water diffusion test as per IEC: 61109-2008

h) Tracking and erosion test as per IEC: 61109-2008.

i) Hardness test as per IEC: 61109-2008.

j) Accelerated weathering test as per IEC: 61109-2008.

k) Flammability test as per IEC: 61109-2008.

l) Silicone content test

Minimum content of silicone shall be 30% and the same shall be verified through FT-IR spectroscopy & TGA analysis or any other approved/ acceptable method.

m) Recovery of Hydrophobicity test

1. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.
2. Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.
3. Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.
4. Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

n) Torsion test

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Three complete insulators of each electrical and mechanical rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

- o) Accelerated ageing test of 5000hrs as described in appendix-C of IEC 61109 or Test at multiple stresses of 5000 hrs as described in Annex-B of IEC - 62217

2.4.3.2 Acceptance Tests:

For Composite Long Rod Polymer Insulators

a.	Verification of dimensions	IEC : 61109-2008
b.	Galvanizing test	IEC : 60383
c.	Verification of end fittings	IEC : 61109-2008
d.	Recovery of Hydrophobicity	As per Cl. 2.4.3.1.2.m) above
e.	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109-2008
f.	Silicone content test	As per Cl. 2.4.3.1.2.l) above
g.	Brittle fracture resistance test	As per Cl. 2.4.3.1.2.e) above
h.	Dye penetration test	IEC : 61109-2008
i.	Water diffusion test	IEC : 61109-2008

In the event of failure of the sample to satisfy the acceptance test(s) specified in **2.4.3.2** above, the **re-test** procedure shall be as per IEC 61109.

2.4.3.3 Routine Tests

For Composite Long Rod Polymer Insulator Units

a)	Visual Examination	As per IEC:61109-2008
b)	Mechanical routine test	As per IEC:61109 -2008

2.4.4 Guaranteed Technical Particulars for Composite Long Rod Polymer Insulators

The technical parameters for composite long rod polymer insulator string shall be same of the insulator string specified in clause 2.3.2 of this section.

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3.0 AAC / ACSR CONDUCTOR

3.1 Details of AAC Conductor

- 3.1.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

The contractor shall supply the conductor as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.2 Details of ACSR Conductor

- 3.2.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

- 3.2.2 The details of the ACSR Bersimis, ACSR Moose, ACSR Zebra and ACSR Panther conductors shall be as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.3 Workmanship

- 3.3.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (**protrusion** of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

- 3.3.2 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions, etc., after drawing.

- 3.3.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the guaranteed technical particulars. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 60888.

- 3.3.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanisation during pre-forming and post-forming operation.

3.4 Joints in Wires

3.4.1 Aluminium Wires

- 3.4.1.1 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

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3.4.1.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

3.4.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

3.4.2 Steel Wires

There shall be no joint of any kind in the finished wire **used for the manufacturing** of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

3.5 Tolerances

The manufacturing tolerances to the extent indicated in the guaranteed technical particulars shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

3.6 Materials

3.6.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC:60889.

3.6.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the guaranteed technical particulars.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

3.6.3 Zinc

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS:209 -1979.

3.7 Standard Length

3.7.1 The conductor shall be supplied as required. No joint shall be allowed within a single span of stringing, jumpers and equipment interconnection.

3.8 Tests:

3.8.1 The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

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3.8.1.1 Type Tests

In accordance with the stipulation of specification, the following type tests reports of the conductor shall be submitted for approval as per clause 9.2 of Section -GTR.

- | | | | |
|----|------------------------------------------|---|-------------------|
| a) | UTS test on stranded conductor. |) | |
| | |) | |
| b) | Corona extinction voltage test (dry) |) | As per Annexure-A |
| | |) | |
| c) | Radio Interference voltage test (dry) |) | |
| | |) | |
| d) | DC resistance test on stranded conductor |) | |

3.8.1.2 Acceptance Tests

- | | | | |
|----|------------------------------------------------------------------|---|--------------------------|
| a) | Visual check for joints, scratches etc. and lengths of conductor |) | As per Annexure - A |
| | |) | |
| b) | Dimensional check on steel and aluminium strands |) | |
| | |) | |
| c) | Check for lay ratios of various layers |) | -do- |
| | |) | |
| d) | Galvanising test on steel strands |) | |
| | |) | |
| e) | Torsion and Elongation test on steel strands |) | |
| | |) | |
| f) | Breaking load test on steel and aluminium strands |) | |
| | |) | |
| g) | Wrap test on steel and aluminium strands |) | As per IEC:60888 & 60889 |
| | |) | |
| h) | DC resistance test on aluminium strands |) | As per IEC:60889 |
| | |) | |
| i) | UTS test on welded joint of aluminium strands |) | As per Annexure - A |
| | |) | |

NOTE:

All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.

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4.3 Joints in Wires

There shall be no joints of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

4.4 Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in guaranteed Technical Particulars attached with this specification shall only be permitted in the diameter of the individual steel strands and lay length of the earth wire.

4.5 Materials

4.5.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Guaranteed Technical Particulars attached with.

4.5.2 Zinc

The zinc used for galvanising shall be electrolytic High Grade Zinc. It shall conform to and satisfy all the requirements of IS: 209 -1979.

4.6 Standard Length

4.6.1 The standard length of the earth wire shall be as stipulated in Guaranteed Technical Particulars attached with, with the specified tolerance on standard length.

4.8 TESTS

4.8.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

4.8.2 TYPE TESTS

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval as per clause 9.2 of Section - GTR.

- a) UTS test)
 - b) DC resistance test)
- As per Annexure - B

4.8.3 ACCEPTANCE TESTS

- a) Visual check for joints, scratches etc. and length of Earthwire)
 - b) Dimensional check)
 - c) Galvanising test)
 - d) Lay length check)
- As per Annexure - B

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- e) Torsion test)
 - f) Elongation test)
 - g) Wrap test)
 - h) DC resistance test)
 - i) Breaking load test)
 - j) Chemical Analysis of steel)
- IS:398 (Part-III) - 1976

4.8.4 ROUTINE TESTS

- a) Check that there are no cuts, fins etc. on the strands.
- b) Check for correctness of stranding.

4.8.5 TESTS DURING MANUFACTURE

- a) Chemical analysis of zinc used for galvanising) As per Annexure - B
- b) Chemical analysis of steel)

5.0 ALUMINIUM TUBE

5.1 General

Aluminium used shall be grade 63401 WP (range 2) conforming to IS:5082.

The contractor shall supply the aluminium tubes as per the standard guaranteed technical particulars enclosed in Annexure-E of **this section** and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

5.2 Constructional Features

5.2.1 For outer diameter (OD) & thickness of the tube there shall **not** be **any negative** tolerance, other requirements being as per IS: 2678 and IS: 2673.

5.2.2 The welding of aluminium tube shall be done by the qualified welders duly approved by the Employer.

5.3 Tests

In accordance with stipulations of the specification, Routine tests shall be conducted on tubular bus conductors as per IS:5082. Also the wall thickness and ovality of the tube shall be measured.

5.4 Technical Parameters

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE	4.5" AL. TUBE	5" AL. TUBE
1.	Type	3" IPS	4" IPS	4.5" IPS	5" IPS

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		(EH Type)	(EH Type)	(EH Type)	(H Type)
2.	Outer diameter	88.9 mm	114.2 mm	120.00 mm	141.30 mm
3.	Thickness	7.62 mm	8.51 mm	12.00 mm	9.53 mm
4.	Cross-sectional area of aluminium	1945.76 sq.mm	2825.61 sq.mm	4071.50 sq.mm	3945.11 sq.mm
5.	Weight	5.25 kg/m	7.7 kg/m	11.034 kg/m	10.652 kg/m

Sl. No.	Description	6" AL. TUBE	8" AL. TUBE	10" AL. TUBE
1.	Type	6" IPS (H Type)	8" IPS (H Type)	10" IPS (H Type)
2.	Outer diameter	150 mm	202 mm	252 mm
3.	Thickness	10 mm	16 mm	17 mm
4.	Cross-sectional area of aluminium	4398.2 Sq mm	9349.3 sq.mm	12550.6 sq.mm
5.	Weight	11.875 kg/m	25.243 kg/m	33.887 kg/m

6.0 **EARTHING CONDUCTORS**

6.1 **General**

All conductors buried in earth and concrete shall be of mild steel. All conductors above ground level and earthing leads shall be of galvanised steel, except for cable trench earthing. The minimum sizes of earthing conductor to be used are as indicated in clause 9.4 of this Section.

6.2 **Constructional Features**

6.2.1 **Galvanised Steel**

- a) Steel conductors above ground level shall be galvanised according to IS:2629.
- b) The minimum weight of the zinc coating shall be **610 gm/sq.m for normal area and 900 gm/sq.m for coastal area as specified in Section-Project** and minimum thickness shall be 85 microns.
- c) The galvanised surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surfaces of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

6.3 **Tests**

In accordance with stipulations of the specifications galvanised steel shall be subjected to four one minute dips in copper sulphate solution as per IS : 2633.

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7.0 SPACERS

7.1 General

Spacers shall conform to IS: 10162. The spacers are to be located at a suitable spacing to limit the short circuit forces as per IEC -60865. Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are being used, the spacer span(s) for different conductor / span configurations and corresponding short circuit forces shall be as per Annexure-D. For strung buses, flexible type spacers shall be used whereas for jumpers and other connections rigid type spacers shall be used. All quad/twin conductors between equipments/ bus shall be provided with at least one spacer.

Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are not being used, necessary spacer span calculation shall be provided by the contractor during detailed engineering for the approval of Employer.

7.2 Constructional Features

7.2.1 No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

7.2.2 Spacer design shall be made to take care of fixing and removing during installation and maintenance.

7.2.3 The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

7.3 Tests

Each type of spacers shall be subjected to the following type tests, acceptance tests and routine tests:

7.3.1 **Type Tests: Following type test reports shall be submitted for approval as per clause 9.2 of Section - GTR.**

a) **Clamp slip tests**

The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2 kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests shall be performed on the other clamps of the same sample.

b) Fault current test as per CI 5.14.2 of IS: 10162. Alternately, the same can be carried by simulated short circuit method for which compressive forces shall be based on IEC-60865.

c) Corona Extinction Voltage Test (Dry).

This test shall be performed on 765 kV, 400 kV and 220 kV spacers as per procedure mentioned at Annexure - C, Minimum Corona Extinction voltage shall be as per clause 2.3.2.

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d) RIV Test (Dry)

This test shall be performed as per procedure mentioned at Annexure - C, Maximum RIV levels shall be as per clause 2.3.2.

- e) Resilience test (if applicable)
- f) Tension Test
- g) Log decrement test (if applicable)
- h) Compression test
- i) Galvanising test

7.3.2 Acceptance Test (As per IS:10162)

- a) Visual examination
- b) Dimensional verification
- c) Movement test
- d) Clamp slip test
- e) Clamp bolt torque test (if applicable)
- f) Assembly torque test
- g) Compression test
- h) Tension test
- i) Galvanising test
- j) Hardness test for neoprene (if applicable)

The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.

k) Ultimate Tensile Strength Test

The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. mm.

7.3.3 Routine test

- a) Visual examination
- b) Dimensional verification

8.0 BUS POST INSULATORS

The post insulators shall conform in general to latest IS: 2544, IEC-60168, IEC 60273 and IEC-60815.

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8.1 Constructional Features

- 8.1.1 Bus Post insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.
- 8.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 8.1.3 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.
- 8.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-60815 for the specified pollution level.
- 8.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or damage to conductors or insulators by the formation of substance produced by chemical action.
- 8.1.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 8.1.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS: 2633, & IS: 2629. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.
- 8.1.8
- a) Every bolt shall be provided with a hot dip galvanised steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.
 - b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
 - c) All bolts and nuts shall be of steel with well formed hexagonal heads forged from the solid and shall be hot dip galvanised. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.
- 8.1.9 Bidder shall furnish drawings for the essential design features of assembly of shells and metal parts, and number of shells per insulator.

8.2 Tests

In accordance with the stipulations of the specification, the post insulators shall be subjected to type, acceptance, sample and routine tests as per IEC-60168.

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8.2.1 In accordance with the stipulation of specification, the following **type tests** reports of the post insulators shall be submitted for approval as per clause 9.2 of Section - GTR.

- a) Power frequency withstand test (dry & wet)
- b) Lightning impulse test (dry)
- c) Switching impulse test (wet) (For 420 kV and above class Insulator only)
- d) Measurement of R.I.V (Dry) (As per Annexure – C)
- e) Corona extinction voltage test (Dry) (As per Annexure – C)
- f) Test for deflection under load
- g) Test for mechanical strength.

8.2.2 In addition to acceptance/sample/routine tests as per IEC-60168, the following tests shall also be carried out.

- a) Soundness test, metallurgical tests and magnetic particle Inspection (**MPI**) test on MCI/SGI caps as acceptance test.
- b) All hot dip galvanised components shall be subjected to check for uniformity of thickness and weight of zinc coating on sample basis as an acceptance test.
- c) The bending test shall be carried out at 50% minimum cantilever strength load in four directions as a routine test and at 100% minimum cantilever strength load in four directions as an acceptance test.
- d) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

8.3 Technical Parameters of Bus Post Insulators.

Sl. No.	Description	800 kV	420 kV	245 kV	145 kV
a)	Type	Solid Core	Solid Core	Solid Core	Solid Core
b)	Voltage Class (kV)	800	420	245	145
c)	Dry and wet one minute power frequency withstand voltage (kV rms)	830	680	460	275
d)	Dry lightning impulse withstand Voltage (kVp)	±2100	±1425	±1050	±650
e)	Wet switching surge withstand voltage (kVp)	±1550	±1050	—	—
f)	Max. radio interference voltage (in microvolts) - Dry	1000 at 508 kV	500 at 305 kV	500 at 156 kV	500 at 105 kV
g)	Corona extinction voltage (kV rms) (min.)	508	320	156	105

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h)	Cantilever Strength				
(i)	Total minimum cantilever strength (Kg)	800	800	800	600
i)	Minimum torsional moment	As per IEC-60273	As per IEC-60273	As per IEC-60273	As per IEC-60273
j)	Total height of insulator (mm)	5700	3650	2300	1500
k)	P.C.D Top (mm)	225	127	127	127
	Bottom (mm)	325	300	254	254
l)	No. of bolts				
	Top	4	4	4	4
	Bottom	8	8	8	8
m)	Diameter of bolt/holes (mm)				
	Top	M16	M16	M16	M16
	Bottom dia	18	18	18	18
n)	Pollution level as per IEC-60815	Heavy(III)	Heavy(III)	Heavy(III)	Heavy(III)
o)	Minimum total creepage distance for Heavy Pollution (mm)	20000	10500	6125	3165

8.3.1 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor. Aluminium used for corona ring shall be of grade 63401 or 19501 conforming to IS:5082.

9.0 EARTHING

9.1 The earthing shall be done in accordance with requirements given hereunder and drawing titled 'Earthing Details' enclosed with the specification. The spacing for the main earthmat shall be provided by the Employer and the earthmat layout drawings shall be prepared by the contractor based on the spacing provided by the Employer. The resistivity of the stone for spreading over the ground shall be considered as 3000 ohm-m under wet condition. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the minimum resistivity value of stone considered in earth mat design. For measurement purpose, one sample of stones from each source (in case stones are supplied from more than one source) shall be used. The main earthmat shall be laid in the switchyard area in accordance with the approved earthmat layout.

9.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

9.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

a) Code of practice for Earthing IS: 3043

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- b) Code of practice for the protection of Building and allied structures against lightning IS: 2309.
- c) CEA Safety Regulations 2010 & Indian Electricity Act 2003 with latest amendments.
- d) National Electricity Safety code IEEE-80.

9.4 **Details of Earthing System**

Sl. No.	Item	Size	Material
a)	Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod as per IS:2062/SAE1018
b)	Conductor above ground & earthing leads (for equipment)	75x12mm G.S. flat	Galvanised Steel
c)	Conductor above ground & earthing leads (for columns & aux. structures)	75x12mm G.S. flat	Galvanised Steel
d)	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, Junction boxes & Lighting Panels etc.	50x6 mm G.S. flat	Galvanised Steel
e)	Rod Earth Electrode	40mm dia, 3000mm long	Mild Steel as per IS:2062/SAE1018
f)	Pipe Earth Electrode (in treated earth pit) as per IS.	40mm dia, 3000mm long	Galvanised steel
g)	Earthing for motors	25x3mm GS flat	Galvanised steel
h)	Earthing conductor along outdoor cable trenches	50x6mm MS flat	Mild steel as per IS:2062/SAE1018
l)	Earthing of Lighting Poles (for lighting poles outside switchyard)	40 mm dia 3000 mm long	Mild steel rod as per IS:2062/SAE1018
j)	Isolator MOM Box	75X12 mm GS flat & Flexible copper braid	Galvanised steel and copper braid

The sizes of the earthing conductor indicated above are the minimum sizes.

9.5 **Earthing Conductor Layout**

- 9.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.
- 9.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.
- 9.5.3 Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on the earthing terminals of the equipment/structure as per "Standard Earthing Details – Drg No. **C/ENG/STD/EARTHINGS/09**" enclosed.

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- 9.5.4 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc., PVC sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- 9.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.
- 9.5.6 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit the site conditions.
- 9.5.7 Earthing conductors embedded in the concrete shall have approximately 50mm concrete cover.

9.6 ELECTRO-MAGNETIC FIELD CONTROL

The contractor shall provide galvanised steel earth wire at 8m level in the area where three interconnection levels (equipment interconnection, bus & jack bus interconnection) are present at 765kV switchyard to limit electric and magnetic field within permissible limit.

9.7 Equipment and Structure Earthing

- 9.7.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Employer.
- 9.7.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.
- 9.7.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
- 9.7.4 Metallic conduits shall not be used as earth continuity conductor.
- 9.7.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- 9.7.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- 9.7.7 Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.
- 9.7.8 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

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The stone spreading shall also be done 2000 mm outside switchyard fence. The criterion for stone spreading shall be followed in line with requirement specified elsewhere in the specification

- 9.7.9 Flexible earthing connectors shall be provided for the moving parts.
- 9.7.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules
- 9.7.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.
- 9.7.12 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Zinc riched enamel paint.
- 9.7.13 One number 40 mm dia, 3000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive voltage transformers, lightning masts and towers with peak.

9.8 Jointing

- 9.8.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.
- 9.8.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
- 9.8.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 9.8.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 9.8.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 9.8.6 All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.
- 9.8.7 The 75x12mm GS flat shall be clamped with the equipment support structures at 1000mm interval.

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9.9 Power Cable Earthing

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

9.10 Specific Requirement for Earthing Systems

9.10.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two numbers pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a ISI marked cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

9.10.2 Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.

9.10.3 Auxiliary earthing mat comprising of 40mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable.

9.11 Insulating mats

9.11.1 The scope covers supply and laying of insulating mats of "class A" conforming to IS: 15652-2006.

9.11.2 These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control & relay panels located in control room building/ Switchyard panel room.

9.11.3 The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature.

9.11.4 Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat.

9.11.5 Insulating mat (**wherever applicable**) shall be of pastable type, to be fixed permanently on the front of the panels except for the chequered plate area which shall not be pasted as per requirement. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652.

9.11.6 Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements.

9.11.7 The insulating mats offered shall conform to IS: 15652-2006.

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10.0 Bus Bars

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification. The bus bar arrangements are shown in electrical layout drawings enclosed with the bid documents.

10.1 The Contractor shall furnish supporting calculations where the design is to be done by the contractor for the bus bars/conductors to show adequacy of design parameters for:

- a) Fibre-stress (applicable for aluminum tube)
- b) Cantilever strength of post insulators (applicable for aluminum tube)
- c) Aeolian vibrations (applicable for aluminum tube)
- d) Vertical deflection of bus bars (applicable for aluminum tube)
- e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

10.1.1 The welds in the aluminium tubes shall be kept to the minimum and there shall not be more than one weld per span. The procedure and details of welding shall be subject to Employer's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length

10.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminium alloy similar to that of clamps & connectors.

10.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

10.1.4 Details of past experience of the persons proposed to be employed for Aluminium tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished **to Employer**. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX.

10.1.5 Joints shall be avoided in strung bus to avoid joint failure / hot spots and hardwares to be designed accordingly.

11.0 BAY EQUIPMENT

11.1 The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

11.2 Bay Marshalling Kiosk:-

Bay marshalling kiosk shall be fabricated from 304 grade stainless steel of minimum thickness of 1.6mm. For other constructional details, technical specification of section-GTR shall be referred. Further, for stainless steel type bay marshaling kiosk, no painting is envisaged.

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One no. of bay marshalling kiosk shall be provided for each 765 kV, 400 kV, 220 kV and 132 kV bay under present scope. For one and half breaker scheme, one number bay marshalling kiosk shall be provided for each controlling feeder (Line/ transformer/ bus reactor etc) of the diameter and no bay marshalling kiosks are required to be provided for the tie bays. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose:-

A. For 765kV , 400 kV & 220 kV Bays

- (i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum nine (9) numbers outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.
- (ii) To distribute minimum two numbers outgoing 415V, 63Amps three phase supplies to be controlled by MCB to be drawn from above 3 phase incomers for supply to switchyard panel rooms.
- (iii) To distribute minimum ten numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.
- (iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

B. For 132kV & 66 kV Bays

- (i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum four (4) number outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.
- (ii) To distribute minimum six (6) numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.
- (iii) 100 nos. terminal blocks in vertical formation for interlocking facilities for substations without automation system.
- (iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

11.3 Further, all Bay Marshalling Kiosks shall be erected such that a minimum height of 1000mm is maintained between FGL & bottom of the marshalling box. Size of Marshalling box shall be such that cables are properly terminated and wires are dressed with provision of loop.

11.4 **BAY AND PHASE IDENTIFICATION**

11.4.1 The name plate for the bays shall be provided by the contractor as per standard drawing (Drawing no. C/ENG/STD/BAY NAME PLATE) enclosed in this technical specification.

11.4.2 All the phases are to be identified by painting the structures Red, Yellow and Blue by reflecting colour as per as built condition. Phase identification colour is to be provided around the top of the structure with colour band of 100 mm width at a height of approximately 2000mm from the finished ground level.

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12.0 LIGHTNING PROTECTION

- 12.1 Direct stroke lightning protection (DSLPP) shall be provided in the EHV switchyard by lightning masts and shield wires. The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLPP calculations.
- 12.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.
- 12.3 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- 12.4 Down conductors shall be cleated on the structures at 2000 mm interval.
- 12.5 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earthmat.
- 12.6 Lightning conductors shall not pass through or run inside G.I. conduits.
- 12.7 Lightning protection shall also be provided for various buildings like control building, FFPH, Township buildings as per relevant standard.

13.0 EQUIPMENT ERECTION DETAILS

- 13.1 All circuit breaker and isolator erection shall be done under the supervision of equipment manufacturer and erection of all switchyard equipments shall be done as per POWERGRID approved Field Quality Plan (FQP) and as per provision of Technical Specification.
- 13.2 For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.
- 13.3 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.
- 13.4 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- 13.5 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.
- All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.
- 13.6 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- 13.7 Handling of equipment shall be done strictly as per manufacturer's/supplier's

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instructions/instruction manual.

13.8 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

13.9 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

14.0 **STORAGE**

14.1 The Contractor shall provide and construct adequate storage shed as per the Filed Quality Plan for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/Employer shall be strictly adhered to. POWERGRID approved Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.

15.0 **CABLING MATERIAL**

15.1 **CABLE TAGS AND MARKERS**

15.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

15.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

15.1.3 Location of cables laid directly underground shall be clearly indicated with cable route marker made of galvanised iron plate.

15.1.4 Location of underground cable joints shall be indicated with cable **route** marker with an additional inscription "Cable joints".

15.1.5 The **cable route** marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings as per relevant standard.

15.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

15.2 **Cable Supports and Cable Tray Mounting Arrangements**

15.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

15.2.2 The supports shall be fabricated from standard structural steel members.

15.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other

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places these will be at an interval of 2000 mm.

15.2.4 Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure.

15.3 Cable Termination and Connections

15.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.

15.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

15.3.3 Supply of all consumable material shall be in the scope of Contractor.

15.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

15.3.5 Control cable inside control panel/switchgear/MCCB/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

15.3.6 The Contractor shall use printed ferrules for control cable cores at all terminations, as instructed by the Employer. Each cable wire shall be identified with a number and detailed cable schedule may be prepared indicating the wire numbers.

15.3.7 Spare cores shall be similarly encased & tagged with cable numbers and coiled up with end cap.

15.3.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

15.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.

15.3.10 The cable glands shall conform to BIS:6121. They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

15.3.11 The cable glands shall also be suitable for dust proof and weather proof termination.

15.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Employer.

15.3.13 Crimping tool used shall be of approved design and make.

15.3.14 Control Cable lugs shall be tinned copper solderless crimping type conforming to

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IS-8309 & 8394. Aluminium Bimetallic lugs for power cables as required shall be used depending upon type of cables and terminations.

15.3.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

15.4 Storage and handling of Cable Drums

15.4.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

16.0 DIRECTLY BURIED CABLES

16.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers.

16.2 The cable (power and control) between LT station, DG set location and fire lighting pump house and control room shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

16.3 Power cables from Main Switchboard to colony shall be laid in buried cable trench. Location of cable termination point at colony shall be as per site condition and shall be decided in consultation with Employer's site-in-charge. Power Cables for oil filtration plant shall be laid in open cable trench or buried trench upto transformer/reactor area and can be looped from adjacent receptacles provided for power supply of oil filtration plant.

16.4 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker. Cable markers shall be grounded in a concrete base.

17.0 INSTALLATION OF CABLES

17.1 Cabling in the control room shall be done on ladder type cable trays for vertical runs while cabling in switchyard area shall be done on angles in the trench.

17.2 All cables from bay cable trench to equipments including and all interpole cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter of class 4 as per IS 4985 which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables. Cable pull boxes of adequate size shall be provided if required. **For vertical runs on equipments, perforated cable trays shall be provided for all equipments under scope of the contract or any equipment to be provided by the owner (including for owner supplied circuit breakers).**

17.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as

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recommended by the cable manufacturer shall be maintained. Embedded pipes shall be dressed properly at the equipment termination points.

- 17.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.
- 17.5 Suitable arrangement should be used between fixed pipe/cable trays and equipment terminal boxes, where vibration is anticipated.
- 17.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.
- a) Power cables preferably on top tiers.
 - b) Control instrumentation and other service cables in bottom tiers.
 - c) For cabling from control room to switchyard in main cable trench, cable shall be laid such that bottom tiers are preferably filled first and top tiers are kept for filling future cables as per the instructions of Engineer-In-Charge.
- 17.7 For Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. Further, for horizontal cables a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables shall be maintained.
- 17.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon-6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.
- 17.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-interlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.
- 17.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:
- | Table of Cable and | Minimum bending radius |
|--------------------|------------------------|
| Power cable | 12 D |
| Control cable | 10 D |
- D is overall diameter of cable
- 17.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth. The size of hume/steel pipe shall be such that approximately 70% area is only occupied. For meeting future requirement, additional hume/steel pipe shall be laid for future bay provision.
- 17.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/ two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.
- 17.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for

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by the drawings, unavoidable or where permitted by the Employer. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.

- 17.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.
- 17.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Employer.
- 17.16 Rollers shall be used at intervals of about two metres while pulling cables to avoid damage.
- 17.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.
- 17.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.
- 17.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of practices.
- 17.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.
- 17.21 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Employer, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.
- 17.22 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.
- 17.23 **Cable trays**
- i) The cable trays shall be of G.S Sheet and minimum thickness of sheet shall be 2mm.
 - ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.
 - a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.
- 17.24 **Conduits, Pipes and Duct Installation**
- 17.24.1 Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland

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sealing fittings, pull boxes etc as required. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

- 17.24.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.
- 17.24.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.
- 17.24.4 Installation of optical cables/ special cables:**
- GI pipe (light grade) of suitable size (minimum 25 mm) along with required bends, joints etc. shall be used for special cables such as cables for visual monitoring system (VMS), substation automation system (SAS). Further, single pipe can be used for laying multiple cables.**
- 17.24.5 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.
- 17.24.6 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.
- 17.24.7 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.
- 17.24.8 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.
- 17.24.9 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.
- 17.24.10 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.
- 17.24.11 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.
- 17.24.12 Spacing of embedded conduits shall be such as to permit flow of concrete between them.
- 17.24.13 Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.
- 17.24.14 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

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- 17.24.15 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.
- 17.24.16 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.
- 17.24.17 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.
- 17.24.18 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
- 17.24.19 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.
- 17.24.20 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 17.24.21 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.
- 17.24.22 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bonding shall be provided around the joint to ensure a continuous ground circuit.
- 17.24.23 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- 17.24.24 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

17.25 **Cable Sealing System**

Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete bay kiosks/switchyard panel room & control rooms in the substations. Cable sealing system shall consist of multi-diameter type peel-able or adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression, single piece wedge with galvanized steel bolts shall be used. 30% spare blocks on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.

Cable sealing system having earthing strip can alternately be used in place of cable gland arrangement for indoor panels such as LCC, C&R, PLCC panels etc.

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18.0 LIGHTING JUNCTION BOX

The Contractor shall supply and install ISI marked junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

19.0 TESTING AND COMMISSIONING

19.1 All pre/commissioning activities and works work for substation equipment shall be carried out in accordance with Employer's "Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-03)" by the contractor. This document shall be provided to the successful contractor during detailed engineering stage. Test results in the prescribed formats shall be duly filled by the contractor and shall be submitted to the Owner in soft form (CD or Pen Drive)

The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates.

19.2 GENERAL CHECKS

- (a) Check for physical damage.
- (b) Visual examination of zinc coating/plating.
- (c) Check from name plate that all items are as per order/specification.
- (d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
- (e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.
- (f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.
- (g) Check cleanliness of insulator and bushings.
- (h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.
- (i) Check for surface finish of grading rings (Corona control ring).

19.3 STATION EARTHING

- a) Check soil resistivity
- b) Check continuity of grid wires
- c) Check earth resistance of the entire grid as well as various sections of the same.
- d) Check for weld joint and application of zinc rich paint on galvanised surfaces.
- e) Dip test on earth conductor prior to use.

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19.4 AAC/ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS

- a) Physical check for finish
- b) Electrical clearance check
- c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.
- d) Millivolt drop test on all power connectors.
- e) Sag and tension check on conductors.

19.5 ALUMINIUM TUBE WELDING

- a) Physical check
- b) Millivolt drop test on all joints.
- c) Dye penetration test & Radiography test on 10% sample basis on weld joints.
- c) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

19.6 INSULATOR

Visual examination for finish, damage, creepage distance etc.

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ANNEXURE "A"

(Testing Procedure for ACSR/AAC Conductor)

1.0 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to 100% of minimum specified UTS and held for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.0 Corona Extinction Voltage Test

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per Annexure-C, Corona extinction voltage shall not be less than 510 kV (rms) & 320 KV (RMS) Line to ground for 765 kV & 400 kV respectively.

3.0 Radio Interference Voltage Test

Under the conditions as specified under (2.0) above, the conductor samples shall have radio interference voltage as indicated in the guaranteed technical particulars enclosed with. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-60437.

4.0 D.C Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per clause no. 12.8 of IS:398 (Part V)-1982. The resistance corrected at 20°C shall conform to the requirements of this specification.

5.0 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

6.0 Chemical Analysis of Aluminium and Steel

Samples taken from the Aluminium ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

7.0 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the inspector. The

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inspector shall visually check for scratches, joints, etc. and that the conductor generally conform to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

8.0 Dimensional Check for Steel and Aluminium Strands.

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

9.0 Check for Lay-ratios of various Layers.

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

10.0 Galvanising Test

The test procedure shall be as specified in IEC:60888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

11.0 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause No. 10.3 of IEC:60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the GTP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

12.0 Procedure Qualification test on welded Aluminium strands

Two Aluminium wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

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ANNEXURE "B"

(Testing procedure for Galvanised Steel Earthwire)

1. UTS TEST

Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at steady rate upto 50% of UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate to 100% of UTS and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.

2. D.C. RESISTANCE TEST

On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. Visual check for joints, scratches etc. and length of earthwire

Earthwire drums shall be rewound in the presence of the inspector. The inspector shall visually check for joints, scratches etc. and see that the earthwire generally conforms to the requirements of this specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

4. TORSION TEST

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

5. DIMENSIONAL CHECK

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. LAY LENGTH CHECK

The lay length shall be checked to ensure that they conform to the requirements of this specification.

7. GALVANISING TEST

The test procedure shall as specified in IS:4826-1968. The material shall conform to the requirements of this specification. The adherence of zinc shall be

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checked by wrapping around a mandrel four times the diameter of steel wire.

8. CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING

Samples taken from zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

9. CHEMICAL ANALYSIS OF STEEL

Samples taken from steel ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

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ANNEXURE-C

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona [applicable for 400kV and above]

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4

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times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

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ANNEXURE – D

A. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 765KV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40kA/50 kA for 1 sec.					
1.	54.0 mtr	QUAD AAC BULL	15 mtr	3.96 T	5.98 T	3.5 mtr
2.	56.0 mtr	QUAD AAC BULL	15 mtr	4.52 T	6.77 T	4.0 mtr
3.	87.9 mtr	QUAD AAC BULL	15 mtr	8.35 T	11.22 T	6.5 mtr
4.	104.0 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	7.5 mtr
5.	108.61 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	8.0 mtr

B. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 400KV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40 kA for 1 sec.					
1.	54 mtr	QUAD ACSR	7 mtr	4 T	5.64 T	6 mtr
2.	70 mtr	TWIN ACSR	7 mtr	4 T	5.64 T	5 mtr
3.	54 mtr	QUAD ACSR	6 mtr	4 T	5.10 T	5 mtr
4.	70 mtr	TWIN ACSR	6 mtr	4 T	5.10 T	5 mtr
5.	48 mtr	QUAD ACSR	6 mtr	4 T	4.82T	5 mtr
6.	52.5 mtr	QUAD ACSR	6 mtr	4 T	4.85T	5 mtr
7.	56.5 mtr	QUAD ACSR	6 mtr	4 T	4.88T	5 mtr
8.	52.5 mtr	TWIN ACSR	6 mtr	4 T	4.97T	5 mtr
9.	56.5 mtr	TWIN ACSR	6 mtr	4 T	5.00 T	5 mtr
II.	For Fault Level of 50 kA for 1 sec.					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	5.10 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	5.18 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	5.20 T	4 mtr
III.	For Fault Level of 63 kA for 1 sec.					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	6.00 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	6.33 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	6.37 T	4 mtr

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ANNEXURE – D

C. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40 kA for 1 sec.					
1.	54 mtr	QUAD ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
2.	54 mtr	TWIN ACSR	4.5 mtr	2 T	3.50 T	2.5 mtr
3.	74 mtr	TWIN ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
4.	54 mtr	QUAD ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
5.	54 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.5 mtr
6.	74 mtr	TWIN ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
7.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.30 T	2.5 mtr
8.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.35 T	2.5 mtr
9.	68 mtr	TWIN ACSR	4.0 mtr	4 T	5.20 T	2.5 mtr
10.	56 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.5 mtr
11.	72 mtr	TWIN ACSR	4.0 mtr	4 T	5.27 T	2.5 mtr
II.	For Fault Level of 50 kA for 1 sec.					
1.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.41 T	2.0 mtr
2.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.0 mtr
3.	36 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.0 mtr

NOTE: ACSR conductor as mentioned above indicates that it is suitable for both ACSR MOOSE as well as ACSR BERSIMIS conductor.

D. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 132 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 31.5kA for 1 sec.					
1.	36 mtr	Twin Moose/ Zebra ACSR	3 mtr	1 T	2.15 T	2.5 mtr
2.	31.5 mtr	Twin Moose/ Zebra ACSR	2.7mtr	1 T	2.15 T	2.5 mtr
3.	48 mtr	Single Moose/ Zebra ACSR	3 mtr	1 T	2.05 T	NA
4.	42 mtr	Single Moose/ Zebra ACSR	2.7 mtr	1 T	2.03 T	NA

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ANNEXURE-E

**STANDARD TECHNICAL DATA SHEETS FOR AAC/ACSR CONDUCTORS,
GS EARTHWIRE AND ALUMINIUM TUBE**

1.0 GENERAL

Employer has standardised the guaranteed technical particulars for the following AAC/ACSR conductors, Galvanised steel earthwire and aluminum tube. The contractor shall supply the conductors as per the standard GTP mentioned below. Any deviation to the following GTP shall be clearly brought out by the bidder in their bid.

1.1 Guaranteed Technical Particulars (GTP) for conductors:

A. GTP of AAC BULL and AAC TARANTULA conductor:

Sl.	Description	Unit	AAC BULL	AAC TARANTULA
1.0	Applicable Standard		IS:398	
2.0	Raw Materials			
2.1	Steel Wire / Rods			
2.1.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	4.25	5.23
b)	Maximum	mm	4.29	5.28
c)	Minimum	mm	4.21	5.18
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.23	3.44
b)	After stranding	KN	2.12	3.27
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm /KM	3.651	3.627
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.00203	0.001341
4.0	AAC Conductor			
4.1. a)	Stranding		Al – 61/4.25 mm	Al – 37/ 5.23 mm
b)	Number of Strands			
i.	1st Aluminium Layer	Nos.	1	1
ii.	2nd Aluminium Layer	Nos.	6	6

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Sl.	Description	Unit	AAC BULL		AAC TARANTULA	
iii.	3rd Aluminium Layer	Nos.	12		12	
iv.	4th Aluminium Layer	Nos.	18		18	
v.	5th Aluminium Layer	Nos.	24		-	
4.2	Sectional Area of aluminium	Sq. mm	865.36		794.80	
4.3	Total sectional area	Sq. mm	865.36		794.80	
4.4	Approximate Weight	Kg/m	2.4		2.191	
4.5	Diameter of the conductor	mm	38.25		36.60	
4.6	UTS of the conductor	kN	139 (Min.)		120 (Min.)	
4.7	Lay ratio of the conductor	mm	Max	Min	Max	Min
a)	6 wire Aluminium layer	mm	16	10	16	10
b)	12 wire Aluminium layer	mm	16	10	16	10
c)	18 wire Aluminium layer	mm	16	10	14	10
d)	24 wire Aluminium layer	mm	14	10	-	-
4.8	DC resistance of the conductor at 20°C	ohm/km	0.03340		0.03628	
4.9	Standard length of the conductor	m	1000		1000	
4.10	Tolerance on Standard length	%	(+/-) 5		(+/-) 5	
4.11	Direction of lay of outer layer		Right Hand		Right Hand	
4.12	Linear mass of the conductor					
a)	Standard	kg/km	2400		2192	
b)	Minimum	kg/km	2355		2150	
c)	Maximum	kg/km	2445		2234	
4.13	Modulus of Elasticity	Kg/sq .mm	4709 (Initial) 5869 (Final)		4709 (Initial) 5869 (Final)	
4.14	Co-efficient of Linear Expansion	Per Deg. C	23.0x10 ⁻⁶		23.0x10 ⁻⁶	
4.15	Minimum Corona Extinction Voltage	KV (rms)	508		320	
4.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 508 kV (rms)		Less than 1000 at 320 kV (rms)	
5.0	Drum Dimensions		Generally conforms to IS:1778			

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Sl.	Description	Unit	AAC BULL	AAC TARANTULA
a)	Flange Diameter	mm	1855	1855
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	850	850
d)	Flange thickness	mm	50x50	50x50

B. GTP of ACSR BERSIMIS and ACSR MOOSE conductor:

Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
1.0	Applicable Standard		IS:398 / IEC - 61089	
2.0	Raw Materials			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	4.57	3.53
b)	Maximum	mm	4.61	3.55
c)	Minimum	mm	4.53	3.51
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.64	1.57
b)	After stranding	KN	2.51	1.49
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm/ KM	1.738	2.921
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.001738	0.002921

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Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
4.0	Steel strand after stranding			
4.1	Diameter			
a)	Nominal	mm	2.54	3.53
b)	Maximum	mm	2.57	3.60
c)	Minimum	mm	2.51	3.46
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	6.87	12.86
b)	After stranding	KN	6.53	12.22
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
5.0	ACSR Conductor			
5.1.a)	Stranding		Al -42/4.57 mm+ Steel-7/2.54 mm	Al -54/3.53 mm+ Steel-7/3.53 mm
b)	Number of Strands			
i.	Steel centre	Nos.	1	1
ii.	1st Steel Layer	Nos.	6	6
iii.	1st Aluminium Layer	Nos.	8	12
iv.	2nd Aluminium Layer	Nos.	14	18
v.	3rd Aluminium Layer	Nos.	20	24
5.2	Sectional Area of aluminium	Sq. mm	689.50	528.50
5.3	Total sectional area	Sq. mm	725.00	597.00
5.4	Approximate Weight	Kg/m	2.181	2.004
5.5	Diameter of the conductor	mm	35.05	31.77
5.6	UTS of the conductor	kN	154 (Min.)	161.20 (Min.)
5.7	Lay ratio of the conductor	mm	Max Min	Max Min

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Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
a)	Outer Steel layer	mm	24 16	18 16
b)	8/12 wire Aluminium layer	mm	17 10	14 12
c)	14/ 18 wire Aluminium layer	mm	16 10	13 11
d)	20/24 wire Aluminium layer	mm	13 10	12 10
5.8	DC resistance of the conductor at 20°C	ohm/km	0.04242	0.05552
5.9	Standard length of the conductor	m	1800	1800
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
5.11	Direction of lay of outer layer	-	Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	kg/km	2181	2004
b)	Minimum	kg/km	2142	1965
c)	Maximum	kg/km	2221	2045
5.13	Modulus of Elasticity (Final State)	Kg/sq .mm		6860
5.14	Co-efficient of Linear Expansion	Per Deg. C	21.5x10 ⁻⁶	19.3x10 ⁻⁶
5.15	Minimum Corona Extinction Voltage	KV (rms)	320	320
5.16	RIV at 1 Mhz under dry condition	Micro volts	Max. 1000 at 320 kV (rms)	Max. 1000 at 320 kV (rms)
6.0	Drum Dimensions		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1800	1800
b)	Traverse width	mm	950	950
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

C. B. GTP of ACSR ZEBRA and ACSR PANTHER conductor:

Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
1.0	Applicable Standard		IS:398 / IEC-61089	
2.0	Raw Materials			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.21	3.03
c)	Minimum	mm	3.15	2.97
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	1.29	1.17
b)	After stranding	KN	1.23	1.11
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.003626	0.004107
4.0	Steel strand after stranding			
4.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.24	3.06
c)	Minimum	mm	3.12	2.94
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	10.43	9.29
b)	After stranding	KN	9.91	8.85
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER		
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)		
5.0	ACSR Conductor					
5.1.a)	Stranding		Al -54/3.18 mm+ Steel-7/3.18 mm	Al -30/3.00 mm+ Steel-7/3.00 mm		
b)	Number of Strands					
i.	Steel centre	Nos.	1	1		
ii.	1st Steel Layer	Nos.	6	6		
iii.	1st Aluminium Layer	Nos.	12	12		
iv.	2nd Aluminium Layer	Nos.	18	18		
v.	3rd Aluminium Layer	Nos.	24	NA		
5.2	Sectional Area of aluminium	Sq. mm	428.9	212.10		
5.3	Total sectional area	Sq. mm	484.5	261.50		
5.4	Approximate Weight	Kg/m	1.621	0.974		
5.5	Diameter of the conductor	Mm	28.62	21.00		
5.6	UTS of the conductor	kN	130.32 (Min.)	89.67 (Min.)		
5.7	Lay ratio of the conductor	mm	Max	Min	Max	Min
a)	Outer Steel layer	mm	28	13	28	16
b)	12 wire Aluminium layer	mm	17	10	16	10
c)	18 wire Aluminium layer	mm	16	10	14	10
d)	24 wire Aluminium layer	mm	14	10	NA	NA
5.8	DC resistance of the conductor at 20°C	ohm/km	0.06868	0.140		
5.9	Standard length of the conductor	m	1800	1800		
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5		
5.11	Direction of lay of outer layer		Right Hand	Right Hand		
5.12	Linear mass of the conductor					
a)	Standard	kg/km	1621	974		
b)	Minimum	kg/	1589	954		

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
		km		
c)	Maximum	kg/ km	1653	993
5.13	Modulus of Elasticity	Kg/sq .mm		8158
5.14	Co-efficient of Linear Expansion	Per Deg. C	19.3x10 ⁻⁶	17.8x10 ⁻⁶
5.15	Minimum Corona Extinction Voltage	KV (rms)	154	92
5.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 154 kV (rms)	Less than 500 at 92 kV (rms)
6.0	Drum Dimensions		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1850	1850
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

1.2 Guaranteed technical particulars of Galvanised Steel Earthwire

	Description	Unit	Standard Values
1.0	Raw Materials		
1.1	Steel wires / rods		
a)	Carbon	%	Not more than 0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	Zinc		
a)	Minimum purity of Zinc	%	99.95
2.0	Steel strands		
2.1	Diameter		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.74
c)	Minimum	mm	3.58
2.2.	Minimum breaking load of strand		
a)	After stranding	KN	10.58
2.3	Galvanising		
a)	Minimum weight of zinc coating per sq.m. after stranding	gms.	275
b)	Minimum number of dips that the galvanized strand can withstand	Nos.	3 dips of 1 minute and

SECTION - (SE)
SWITCHYARD ERECTION

ANNEXURE-E

	in the standard preece test		one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18
3.0	Stranded Earth wire		
3.1	UTS of Earth wire	KN	68.4 (min.)
3.2	Lay length of outer steel layer		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	Maximum DC resistance of earth wire at 20° C	Ohm/km	3.375
3.4	Standard length of earth wire	M	2000 or actual quantity whichever is less.
3.5	Tolerance on standard length	%	±5
3.6	Direction of lay for outside layer		Right hand
3.7	Linear mass		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	552
c)	Minimum	Kg/km	600
3.8	Overall diameter	mm	10.98

1.3 Guaranteed Technical Parameters of Aluminum Tube

A. GTP for 3" IPS & 4" IPS AL. TUBE

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE
1.	Size	3" IPS (EH Type)	4" IPS (EH Type)
2.	Material	Aluminium Alloy 6101 T6 conforms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu	0.05 Max	
ii)	Mg	0.4 to 0.9	
iii)	Si	0.3 to 0.7	
iv)	Fe	0.5 Max	
v)	Mn	0.03 Max	
Vi)	Al	Remainder	
4.	Outer diameter	88.90 mm	114.2 mm
5.	Tolerance on outer diameter	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
6.	Thickness	7.62 mm	8.51 mm
7.	Tolerance on thickness	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
8.	Cross-sectional area	1945.76 sq.mm	2825.61 sq.mm
9.	Weight	5.25 kg/m	7.7 kg/m
10.	Moment of Inertia	1621589.99 mm ⁴	3972577.97 mm ⁴
11.	Section Modulus	36481.21 mm ³	69572.29 mm ³

SECTION - (SE)
SWITCHYARD ERECTION

ANNEXURE-E

12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50 mm	10%	
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20.	Minimum Yield point	17.50 Kg/sq.mm	17.50 Kg/sq.mm
21.	Minimum Breaking Strength	20.42 Kg/sq.mm	20.42 Kg/sq.mm

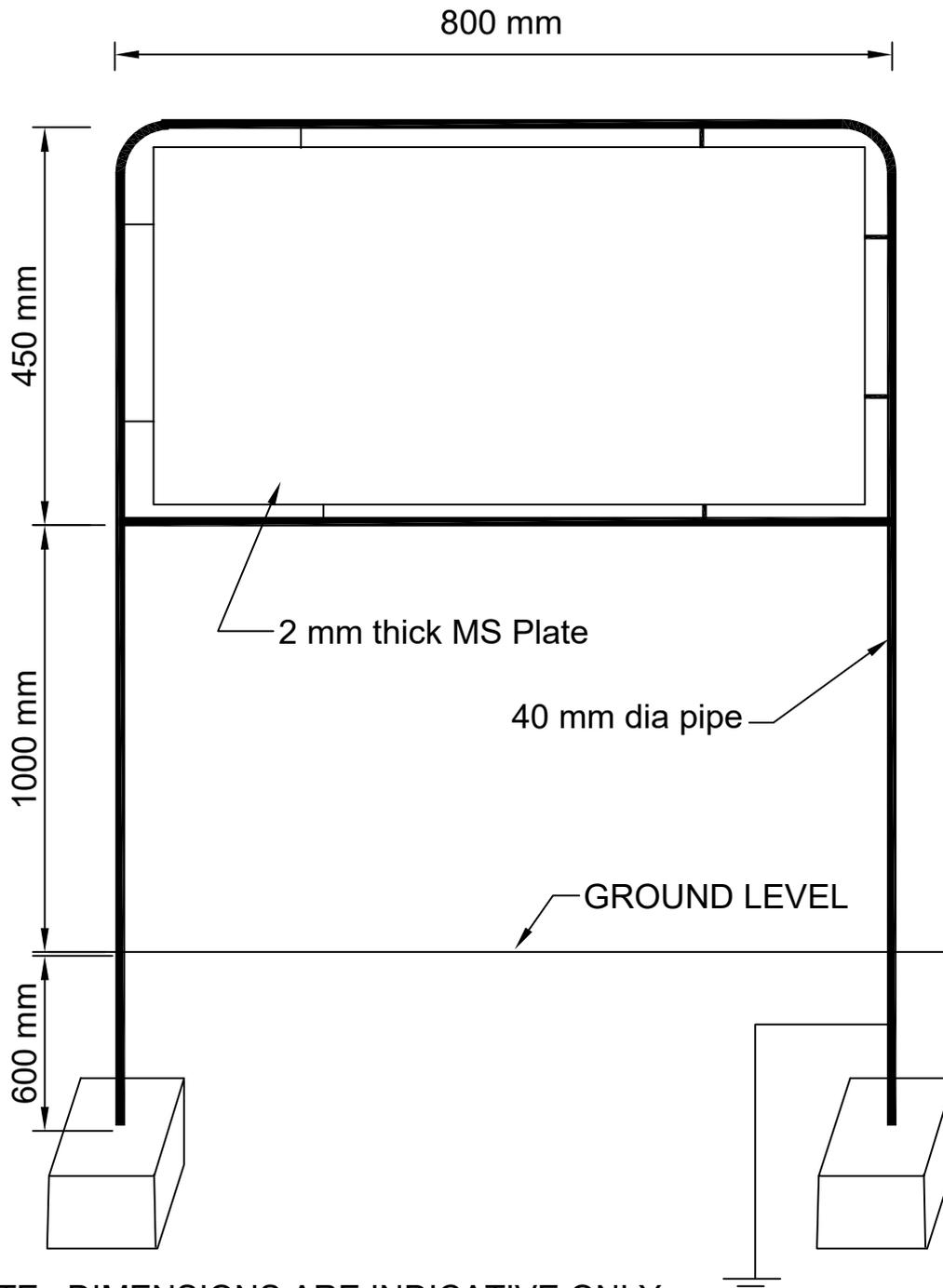
B. GTP for 4.5" IPS & 5" IPS AL. TUBE

Sl. No.	Description	4.5" AL. TUBE	5" AL. TUBE
1.	Size	4.5" IPS (EH Type)	5" IPS
2.	Material	Aluminium Alloy 6101 T6 conforms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
	i) Cu	0.05 Max	
	ii) Mg	0.4 to 0.9	
	iii) Si	0.3 to 0.7	
	iv) Fe	0.5 Max	
	v) Mn	0.03 Max	
	vi) Al	Remainder	
4.	Outer diameter	120.0 mm	141.3 mm
5.	Tolerance on outer diameter	+1.5 mm, - 0.0 mm	+2.8 mm, - 0.0 mm
6.	Thickness	12.0 mm	9.53 mm
7.	Tolerance on thickness	+1.0 mm, - 0.0 mm	+0.8 mm, - 0.0 mm
8.	Cross-sectional area	4071.50 sq.mm	3945.11 sq.mm
9.	Weight	10.993 kg/m	10.652 kg/m
10.	Moment of Inertia	6011958.58 mm ⁴	8610787.65 mm ⁴
11.	Section Modulus	100199.31 mm ³	121879.51 mm ³
12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50	10%	

SECTION - (SE)
SWITCHYARD ERECTION

ANNEXURE-E

	mm		
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20	Minimum Yield point	14.50 Kg/sq.mm	17.50 Kg/sq.mm
21	Minimum Breaking Strength	17.50 Kg/sq.mm	20.42 Kg/sq.mm



NOTE : DIMENSIONS ARE INDICATIVE ONLY.
IT MAY VARY AS PER SITE REQUIREMENT.

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PROJECT :- STANDARD

TITLE:- STANDARD BAY NAME PLATE

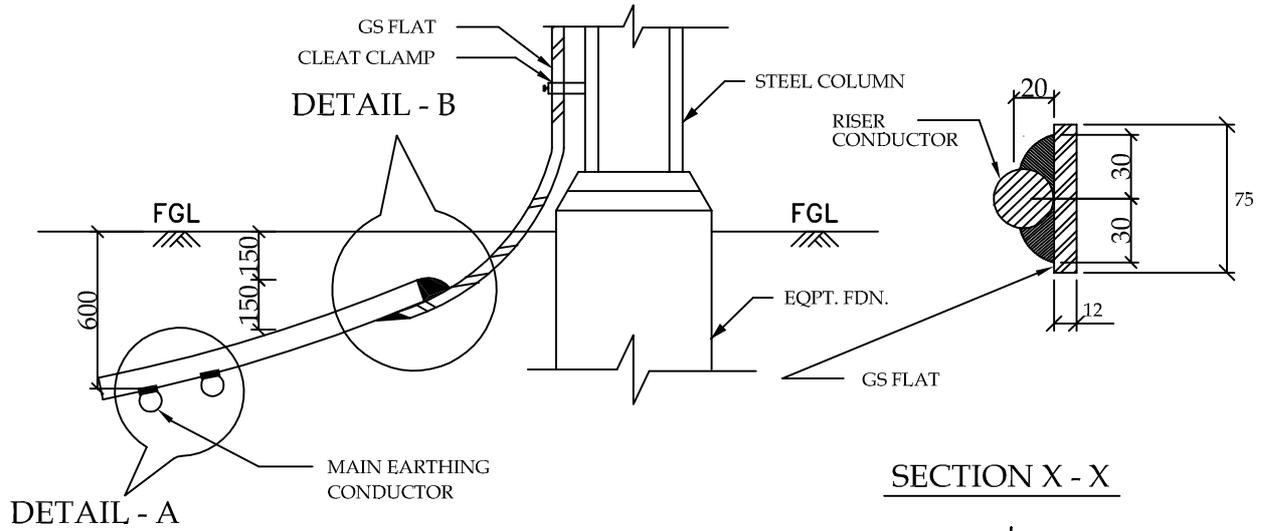
<i>SK/Sankar</i>	<i>SK/Sankar</i>	18/02/2008	Drawing No.:	Rev.
CKD BY	PRPD BY	Date	C/ENG/STD/BAY NAME PLATE	00

GENERAL INSTRUCTION FOR EARTHING:

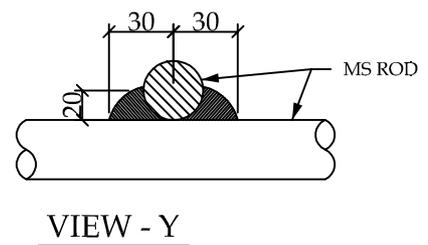
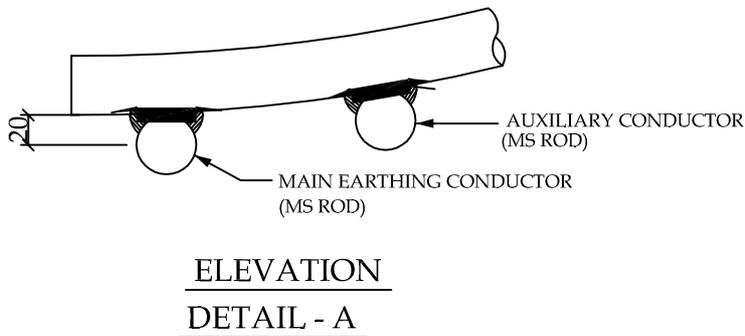
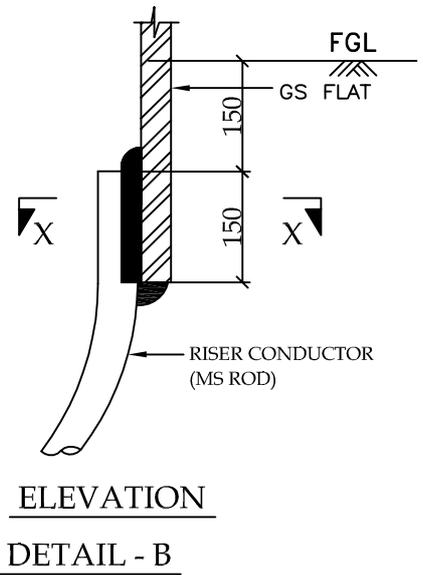
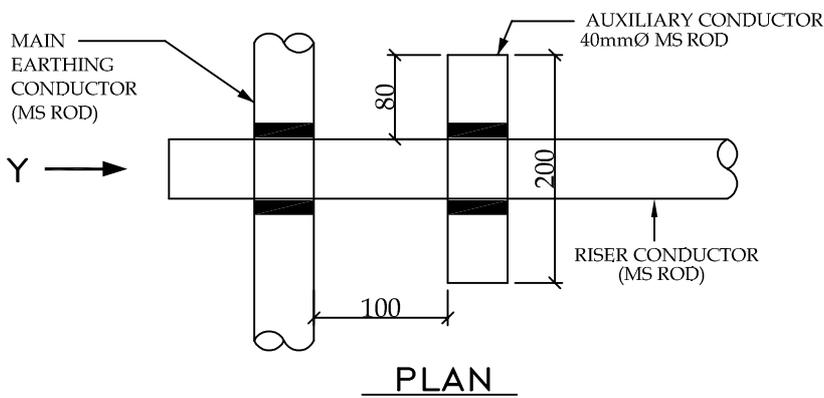
1. Location of earthing conductors / risers shown in the earthing drawing may change to suit the site condition.
2. Two different risers of one structure/equipment shall be connected to different conductors of main earthmat.
3. Earthing conductor around the building shall be buried at a minimum distance of 1500 mm from the outer boundary of the building.
4. Minimum distance of 6000 mm shall be maintained between two treated (pipe) electrode.
5. For surge arrester, earthing lead from surge counter to to main earthmat shall be shortest in length as practically as possible. Earthing lead from surge arrester shall not be passed through any pipe.
6. No welding is allowed in the over ground earthing leads/risers if the length is less than 6m .

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 1
CKD BY	PRPD BY	Date	



TYPICAL DETAILS OF RISER



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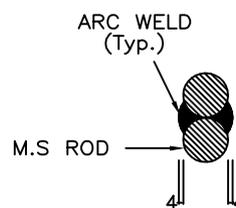
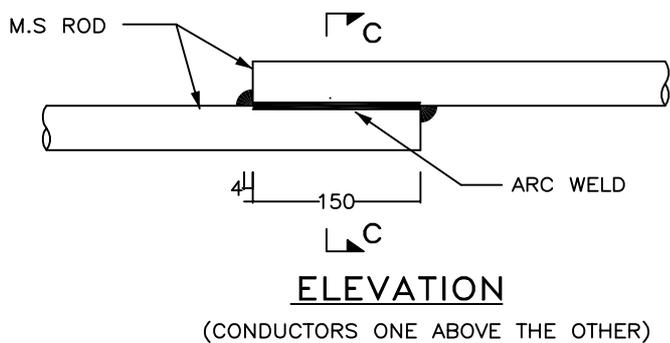
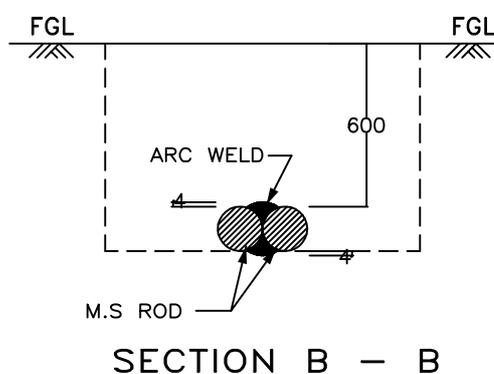
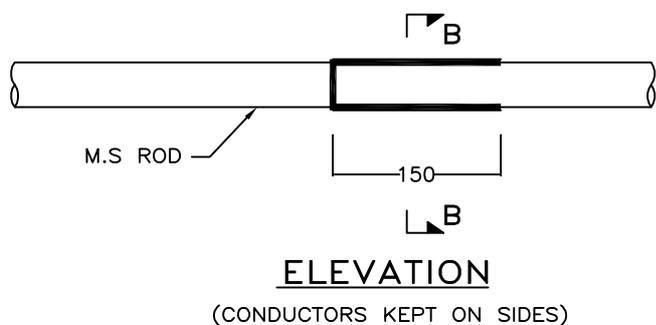
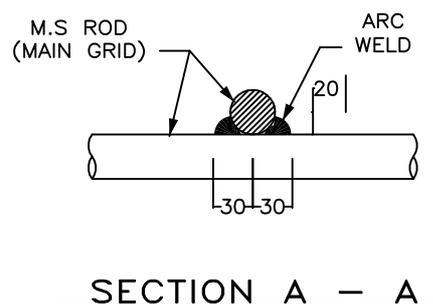
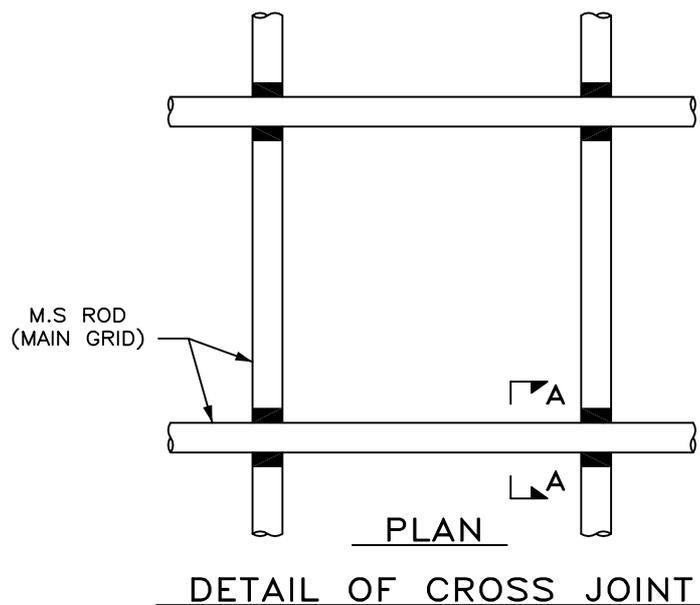
POWER GRID CORPORATION
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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 2
CKD BY	PRPD BY	Date	



DETAIL OF LAP JOINT

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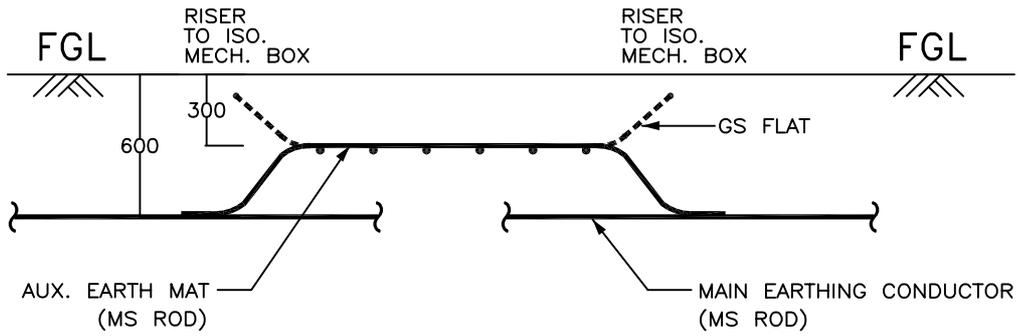
POWER GRID CORPORATION
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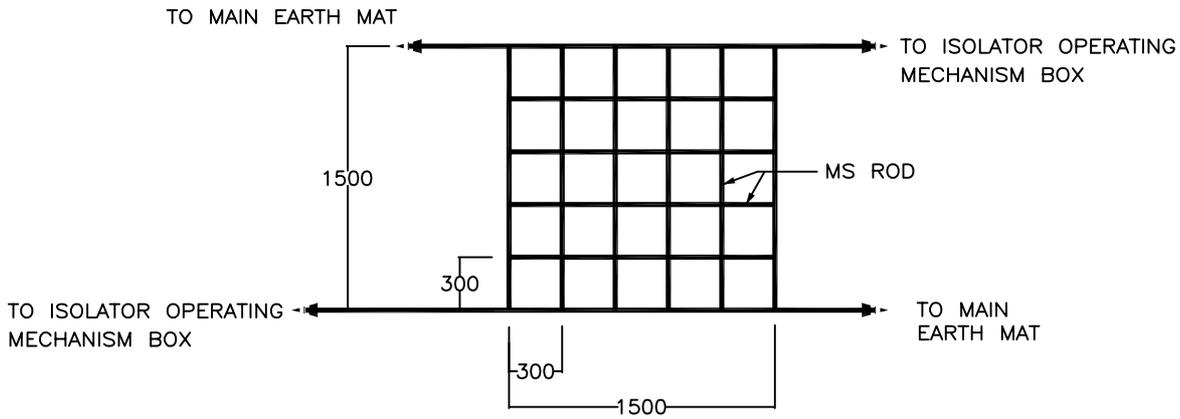
PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

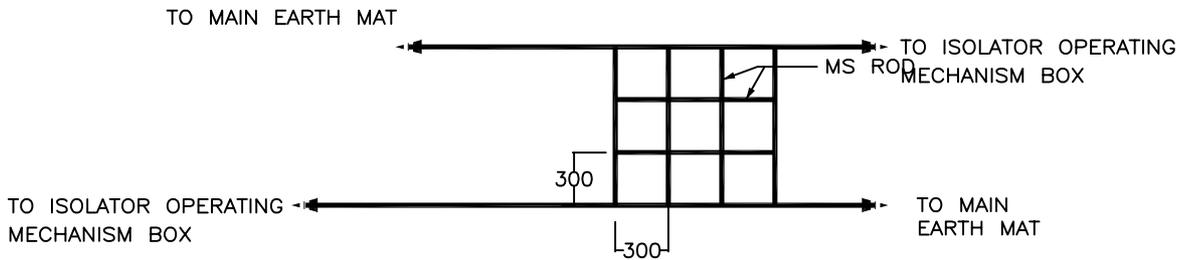
<i>NK Parhar</i>	<i>NK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 3
CKD BY	PRPD BY	Date	



ELEVATION



PLAN (For 220kV & above class isolators)



PLAN (For 132kV & below class isolators)

RELEASED FOR CONTRUCTION

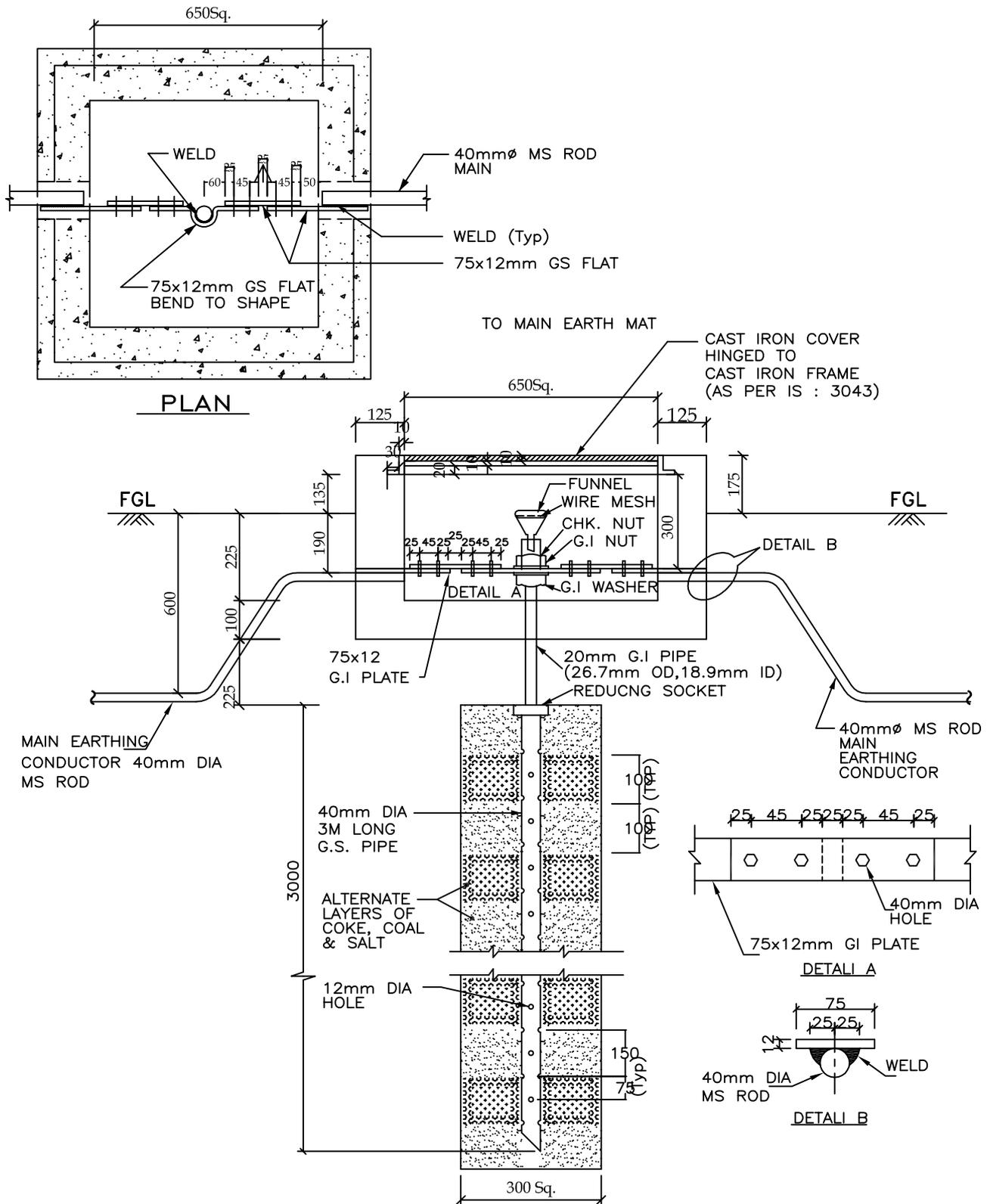
POWER GRID CORPORATION
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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 4
CKD BY	PRPD BY	Date	



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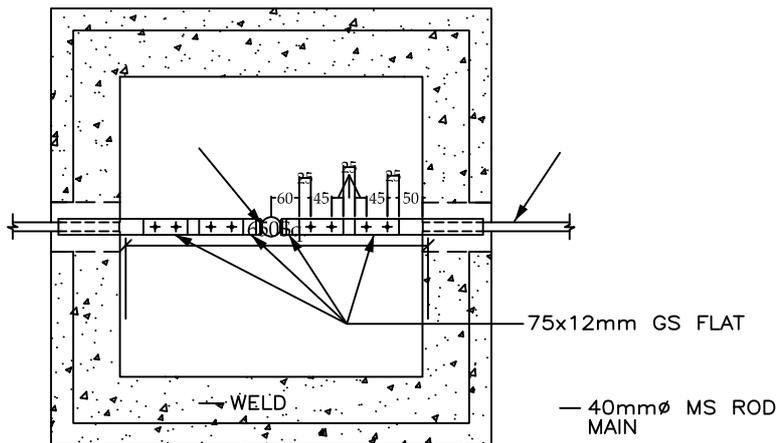


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

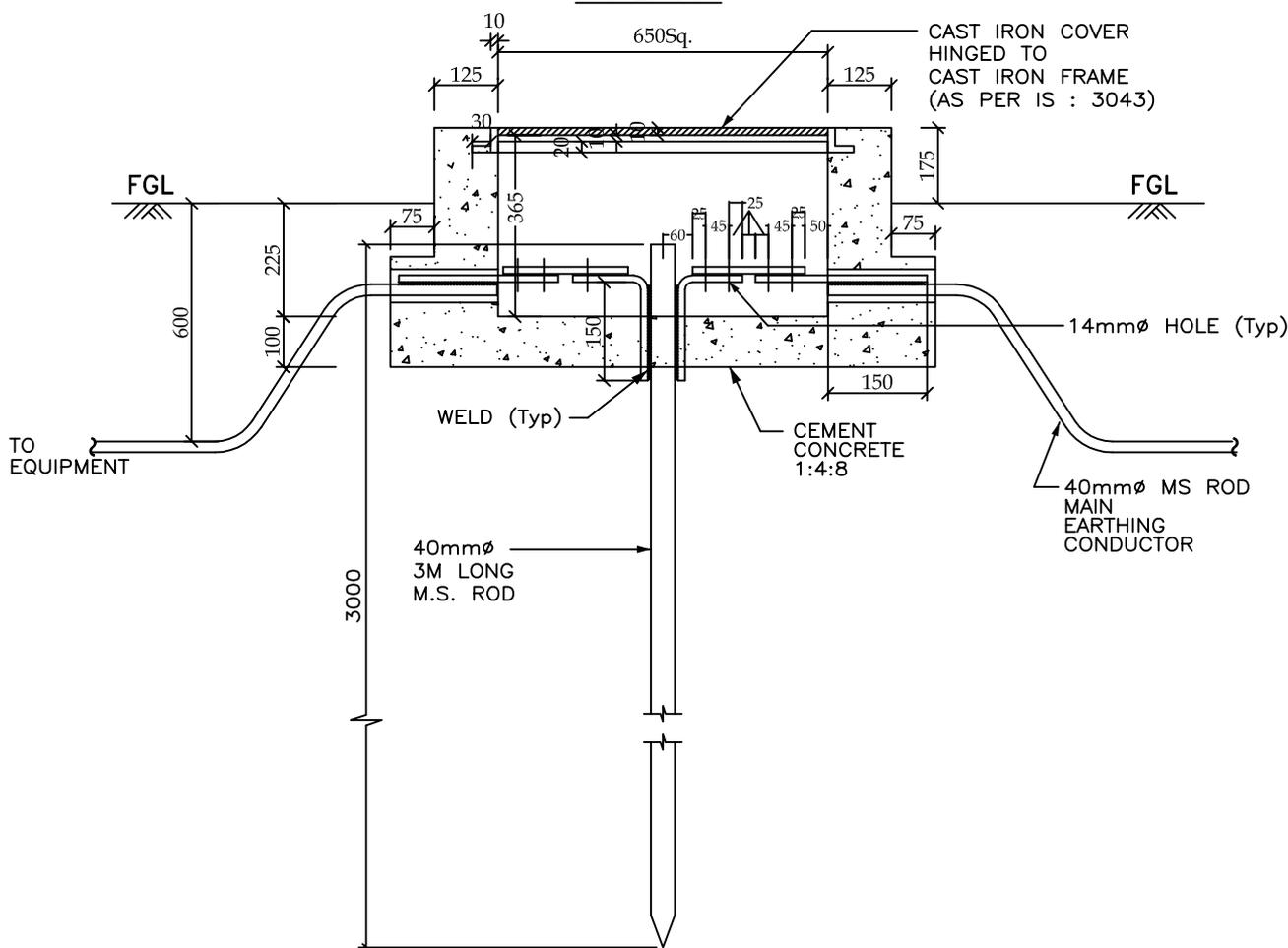
TITLE:- STANDARD EARTHING DETAILS

<i>KK Parshar</i>	<i>KK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 5
CKD BY	PRPD BY	Date	

ROD ELECTRODE WITH TEST LINK FOR LM, TOWER WITH PEAK, CVT, LA



PLAN



ELEVATION

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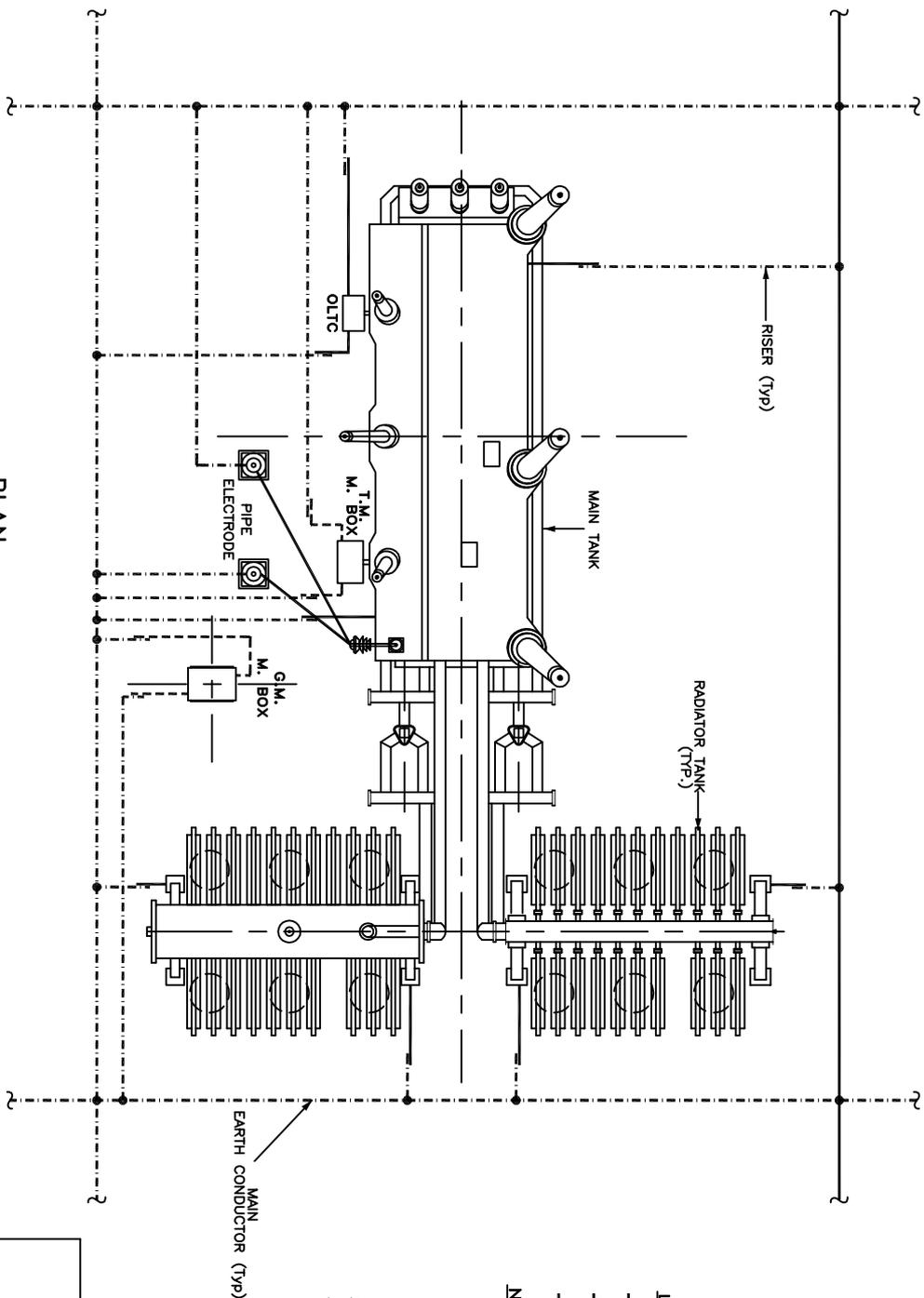


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

CKD BY	PRPD BY	Date	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 6
<i>KK Parshar</i>	<i>KK Parshar</i>	Dec-2013	

EARTHING OF TRANSFORMER / REACTOR



PLAN

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS :-
 MAIN TANK - 2 Nos.
 RADIATOR TANK - 4 Nos.
 O.L.T.C. - 2 Nos. (ICT only)
 M. BOX - 2 Nos./M. BOX
 NEUTRAL EARTH ELECTRODE - 2 Nos.
2. No. OF PIPE ELECTRODE REQUIRED = 2 Nos.
3. PYLON SUPPORTS SHALL BE EARTHED TO THE MAIN EARTHING CONDUCTOR BY GS FLAT.

RELEASED FOR CONTRUCTION

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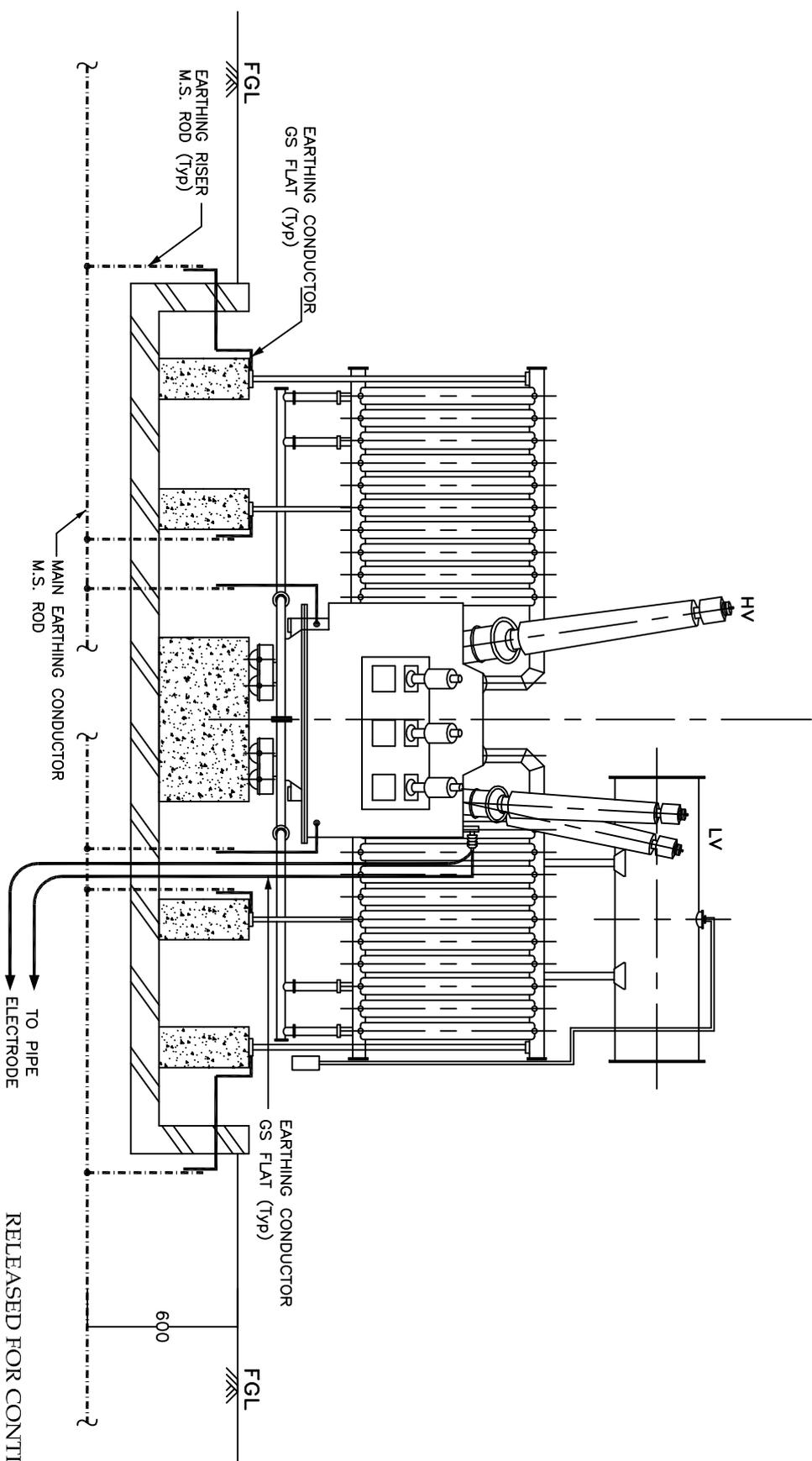


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

CKD BY	PRPD BY	Date	Drawing No.:
Dec-2013	C/ENG/STD/EARTHINGS/09		SHEET # 7

EARTHING OF TRANSFORMER / REACTOR



LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- - - 50 x 6 mm GS FLAT

END VIEW

RELEASED FOR CONTRUCTION

**POWER GRID CORPORATION
OF INDIA LIMITED**
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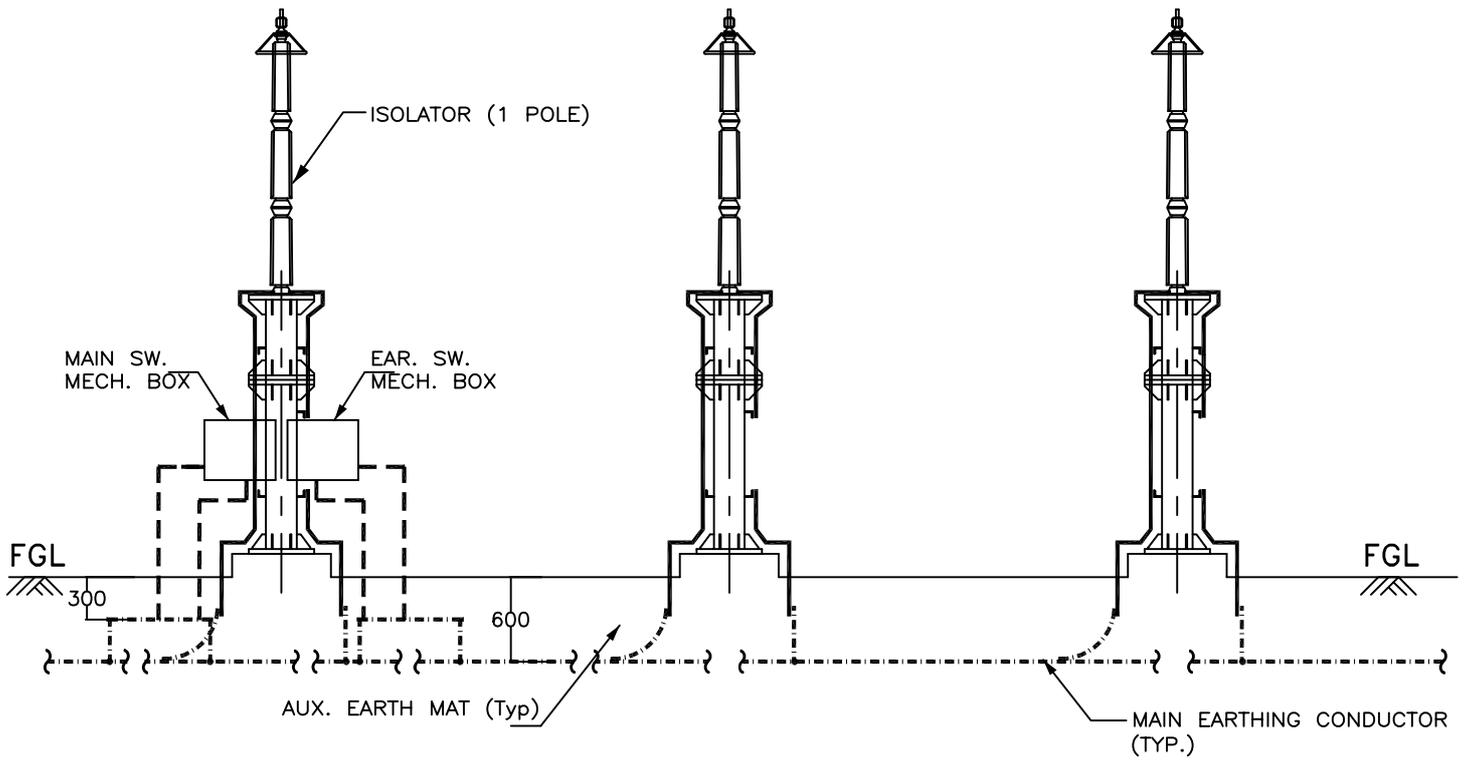


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

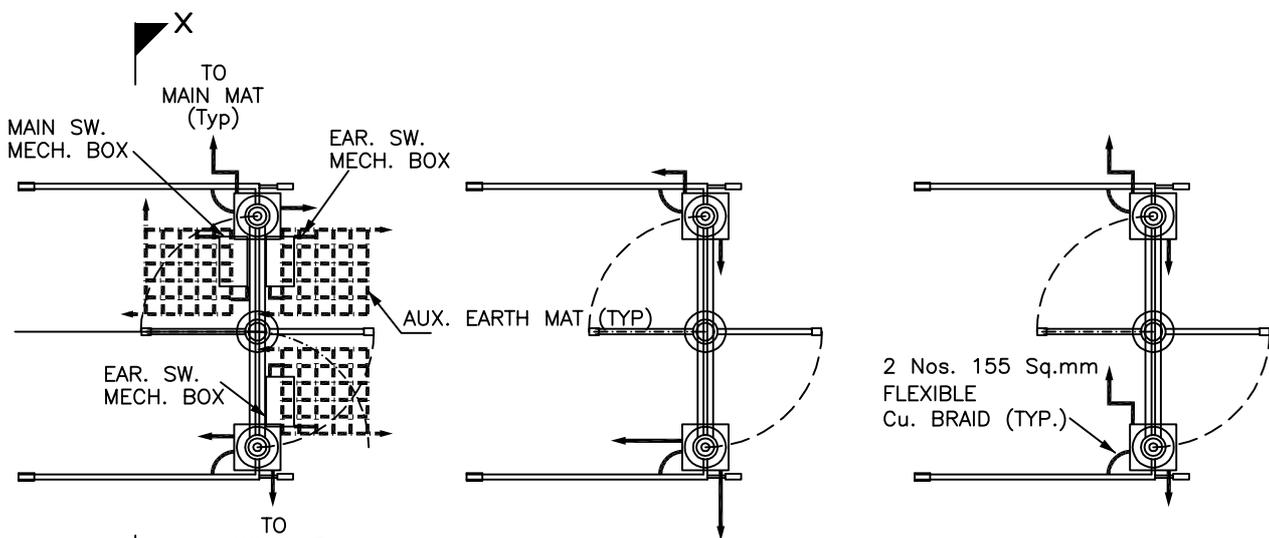
TITLE:- STANDARD EARTHING DETAILS

<i>CKD BY</i>	<i>PRPD BY</i>	<i>Date</i>	<i>Drawing No.:</i>
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 8

EARTHING OF ISOLATOR



ELEVATION

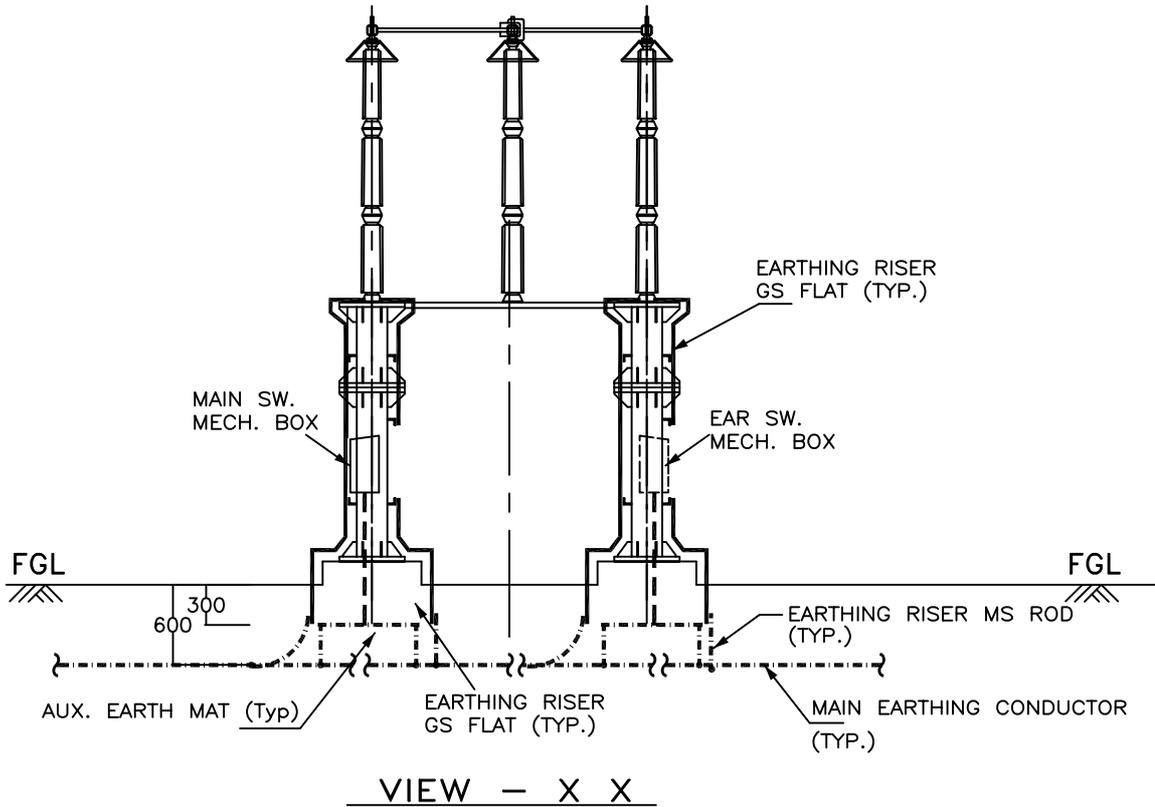


PLAN

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POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)			 पावरग्रिड
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 10

EARTHING OF ISOLATOR (1 PH)



LEGEND

	40mm ϕ MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS FOR ISOLATOR = 4 Nos. / PHASE.
2. No. OF RISERS FOR MAIN MECH. BOX = 2 Nos.
3. No. OF RISERS FOR EARTH SW. MECH. BOX = 2 Nos. / BOX.
4. No. OF AUXILIARY EARTH MAT = 1 Nos. FOR EACH MB
5. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.
6. NO. OF AUX. EARTH MAT IS INDICATIVE ONLY. IT SHALL BE EXECUTED AS PER ACTUAL NUMBER/POSITION OF EARTH SWITCHES.

RELEASED FOR CONTRUCTION

**POWER GRID CORPORATION
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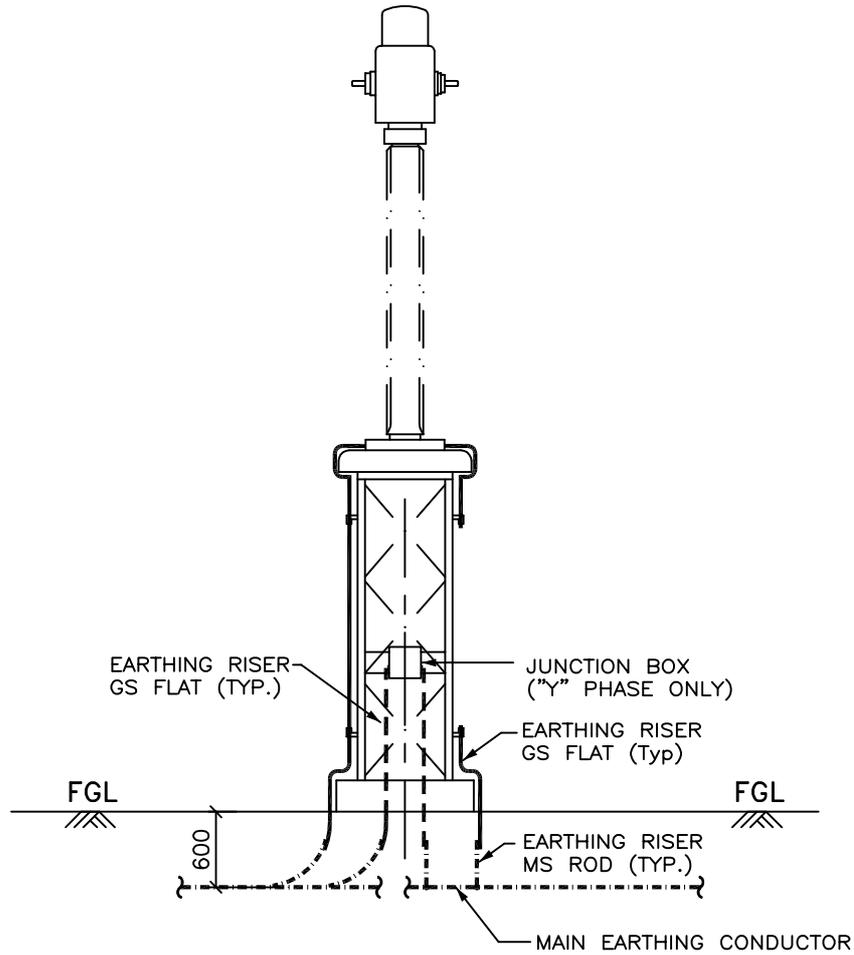


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>NK Parhar</i>	<i>NK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 11
CKD BY	PRPD BY	Date	

EARTHING OF CURRENT TRANSFORMER (1 PH)



ELEVATION

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

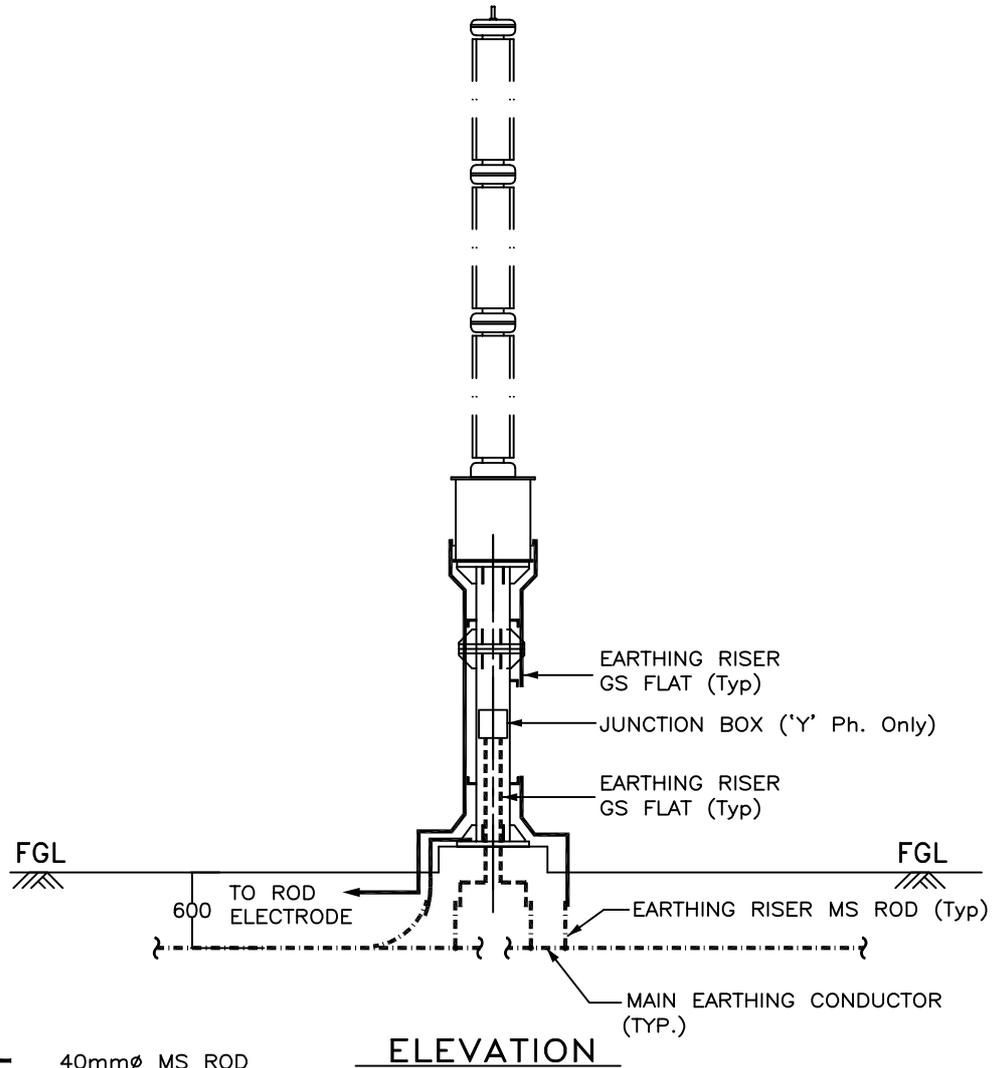
NOTES :-

1. No. OF RISERS = 2 Nos. / PHASE.
2. No. OF RISERS FOR JUN. BOX = 2 Nos.
3. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED <small>(A Government of India Enterprise)</small>			 पावरग्रिड
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>SK Parshar</i>	<i>SK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 12
CKD BY	PRPD BY	Date	

EARTHING OF CAPACITIVE VOLTAGE TRANSFORMER (1 PH)



LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

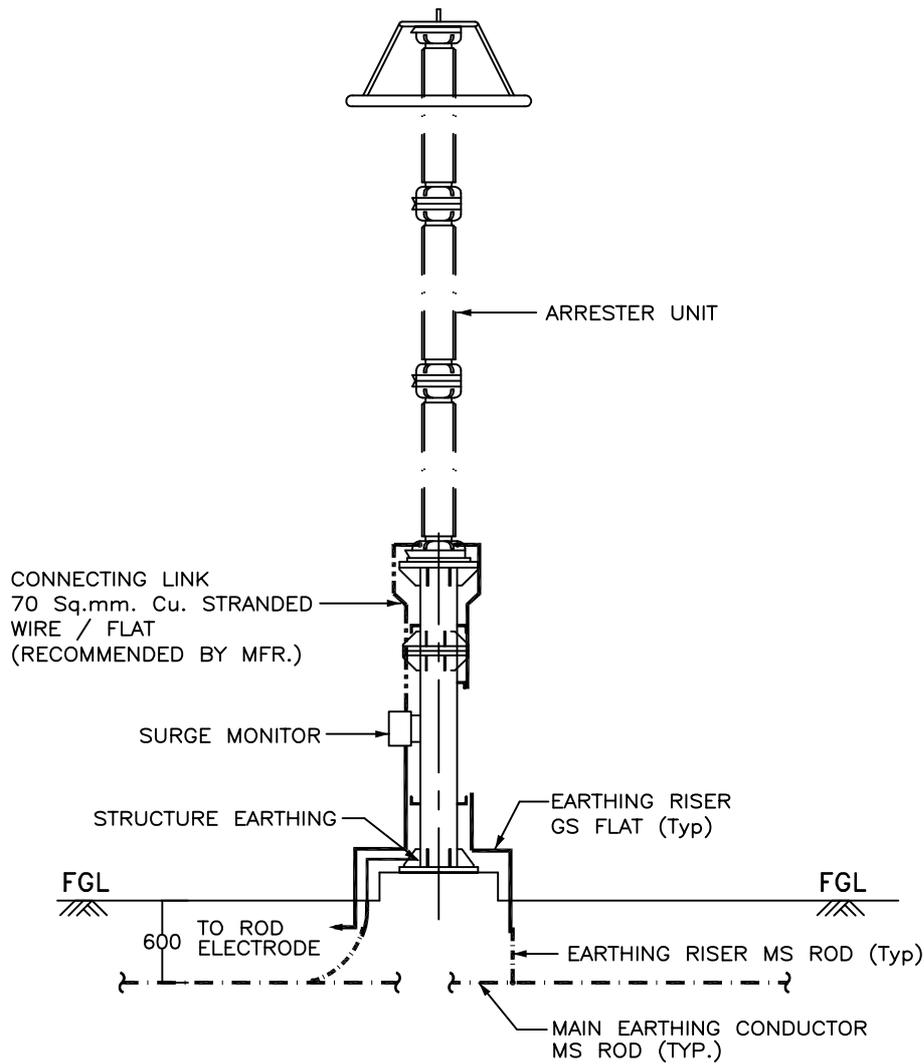
NOTES :-

1. No. OF RISERS = 3 Nos. / PHASE.
2. No. OF RISERS FOR J. BOX = 2 Nos.
3. No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
4. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

<p>POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)</p>			
<p>PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION</p>			
<p>TITLE:- STANDARD EARTHING DETAILS</p>			
<i>SK Parshar</i>	<i>SK Parshar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 13

EARTHING OF SURGE ARRESTER (1PH)



ELEVATION

LEGEND

- · — · — · — · — · — · — 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

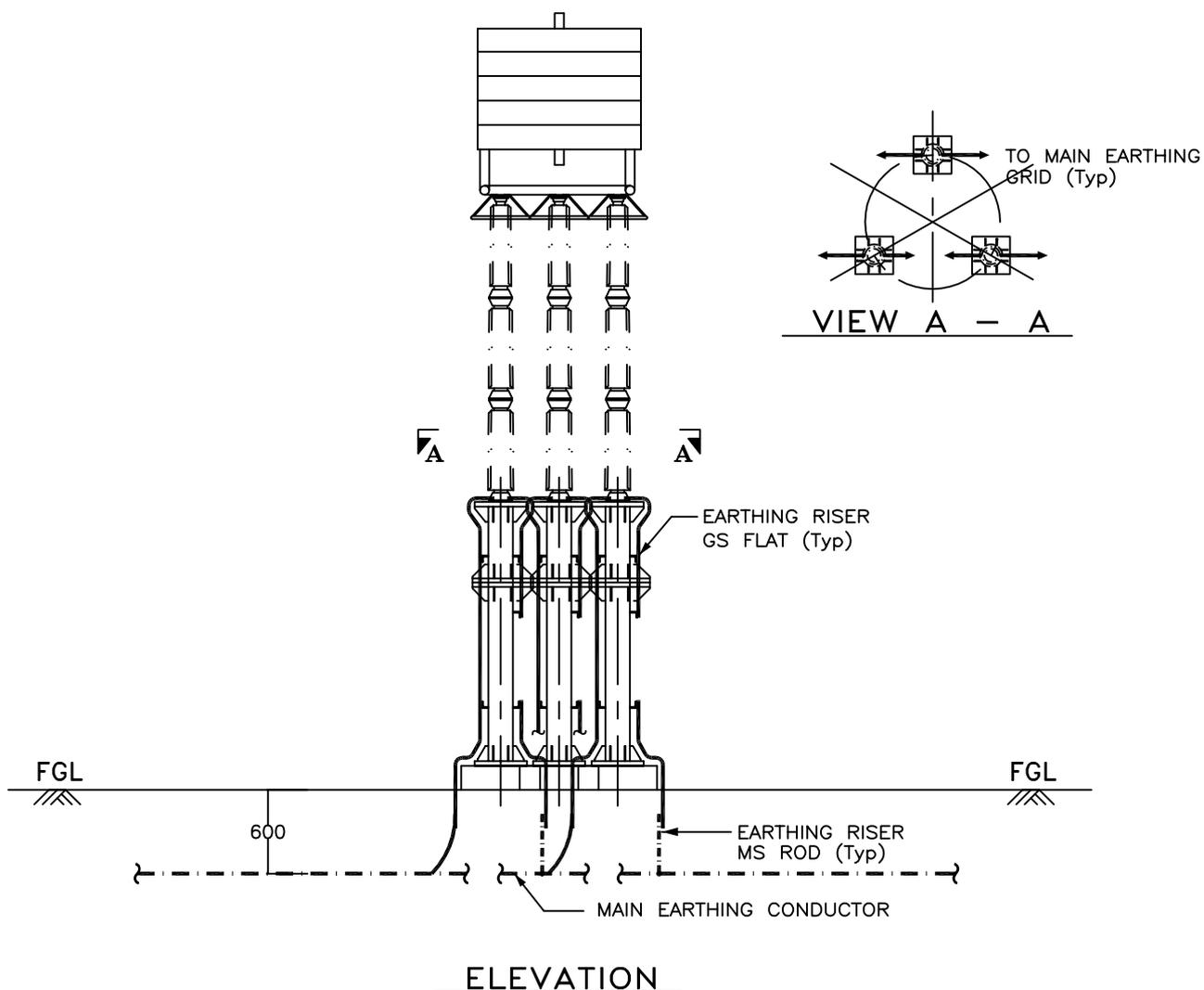
NOTES :-

- 1 . No. OF RISERS = 3 Nos. / PHASE.
- 2 . No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
- 3 . CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)			 पावरग्रिड
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>SK Parshar</i>	<i>SK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 14
CKD BY	PRPD BY	Date	

EARTHING OF WAVE TRAP (1PH)



LEGEND

- · — · — · — 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

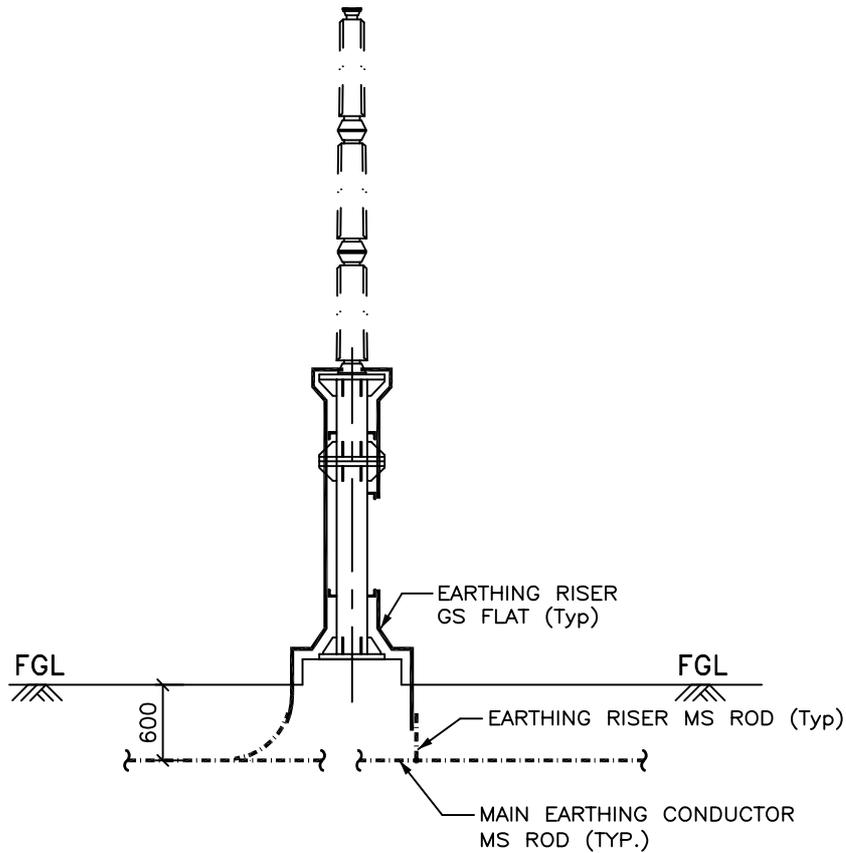
NOTE :-

1. No. OF RISERS = 6 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED <small>(A Government of India Enterprise)</small>			 पावरग्रिड
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 15
CKD BY	PRPD BY	Date	

EARTHING OF POST INSULATOR (1PH)



ELEVATION

LEGEND

- 40mm ϕ MS ROD
 75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

**POWER GRID CORPORATION
OF INDIA LIMITED**
 (A Government of India Enterprise)

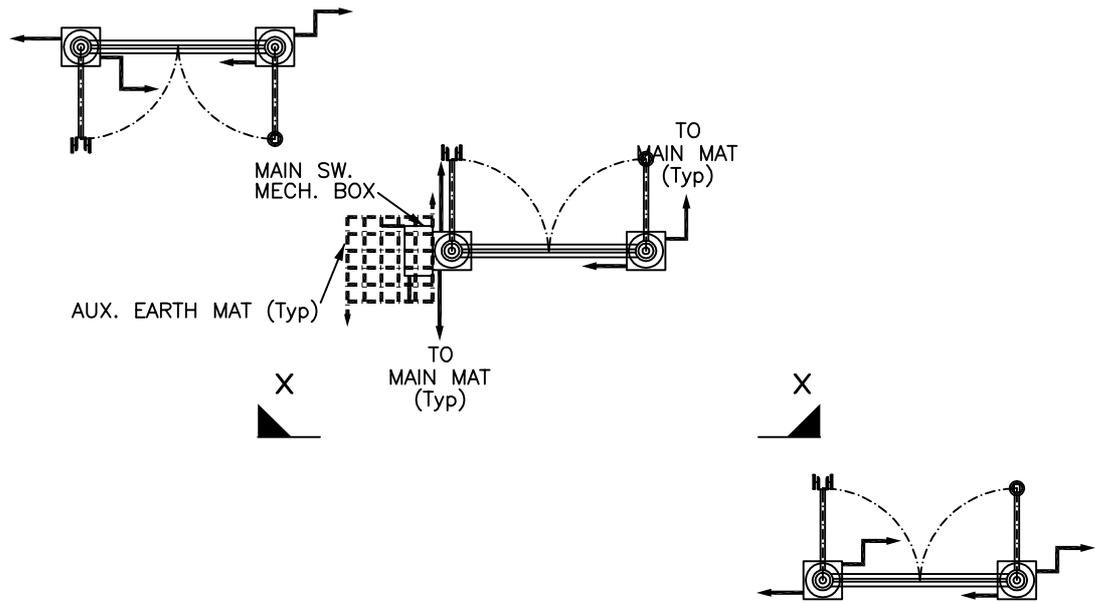
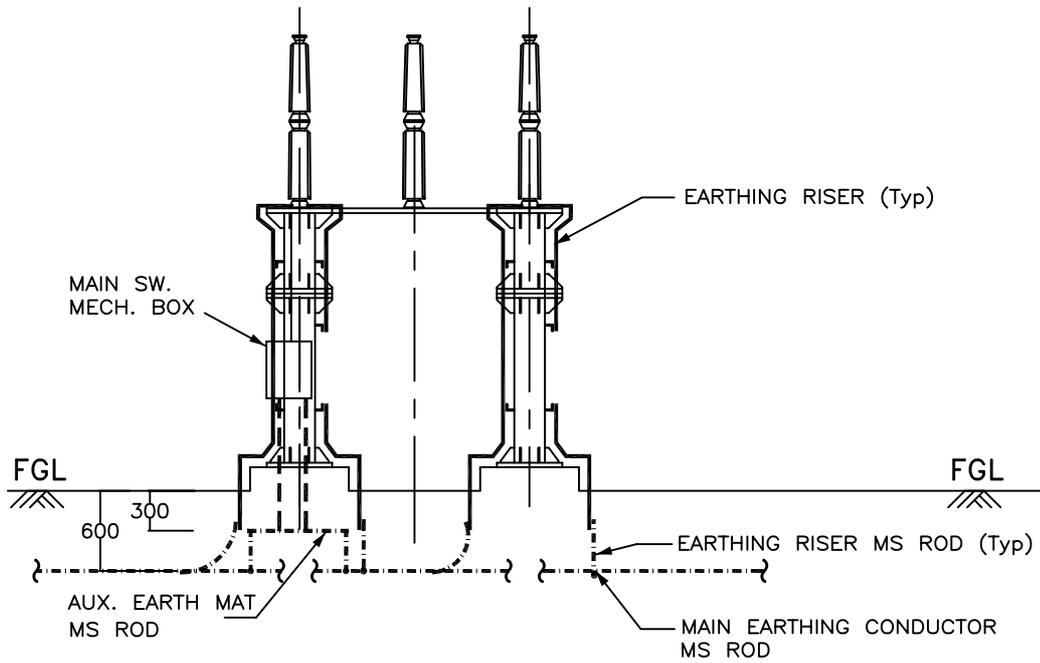


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 16

TANDEM ISOLATOR



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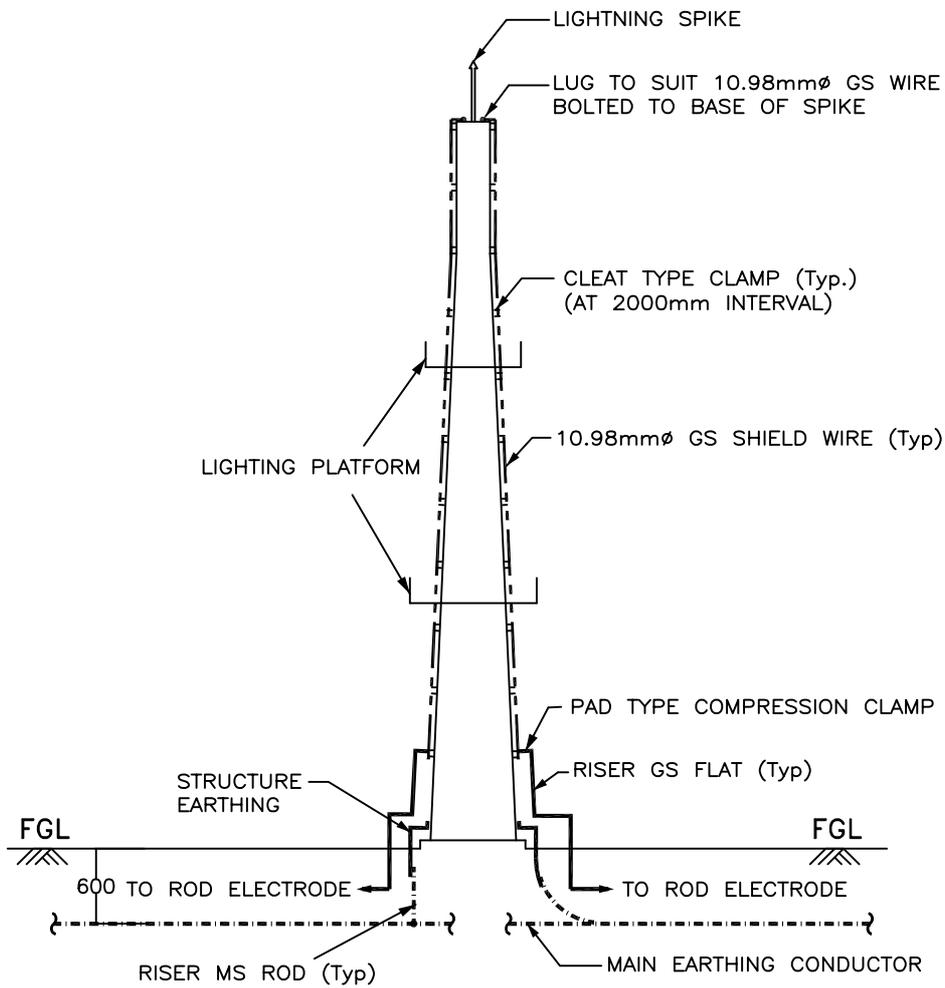


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>SK Parshar</i>	<i>SK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 17
CKD BY	PRPD BY	Date	

EARTHING OF LIGHTNING MAST



NOTES :-

1. No. OF RISERS = 4 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 2 Nos.
3. No. OF PAD TYPE CLAMP = 2 Nos.

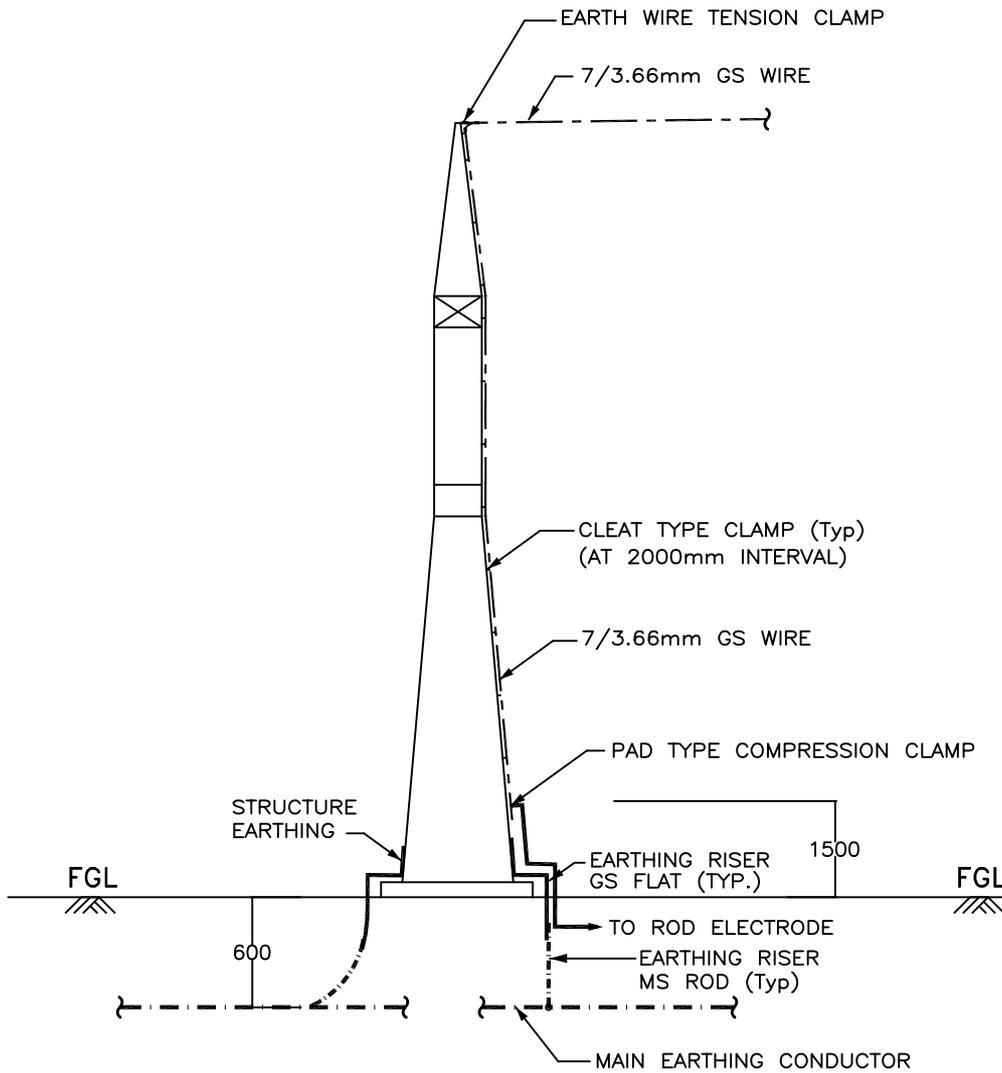
LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

RELEASED FOR CONTRUCTION

<p>POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)</p>			<p>पावरग्रिड</p>
<p>PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION</p>			
<p>TITLE:- STANDARD EARTHING DETAILS</p>			
<i>NK Parhar</i>	<i>NK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 18

EARTHING OF TOWER WITH PEAK



ELEVATION

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 3 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 1 No.
3. No. OF PAD TYPE CLAMP = 1 No.

RELEASED FOR CONTRUCTION

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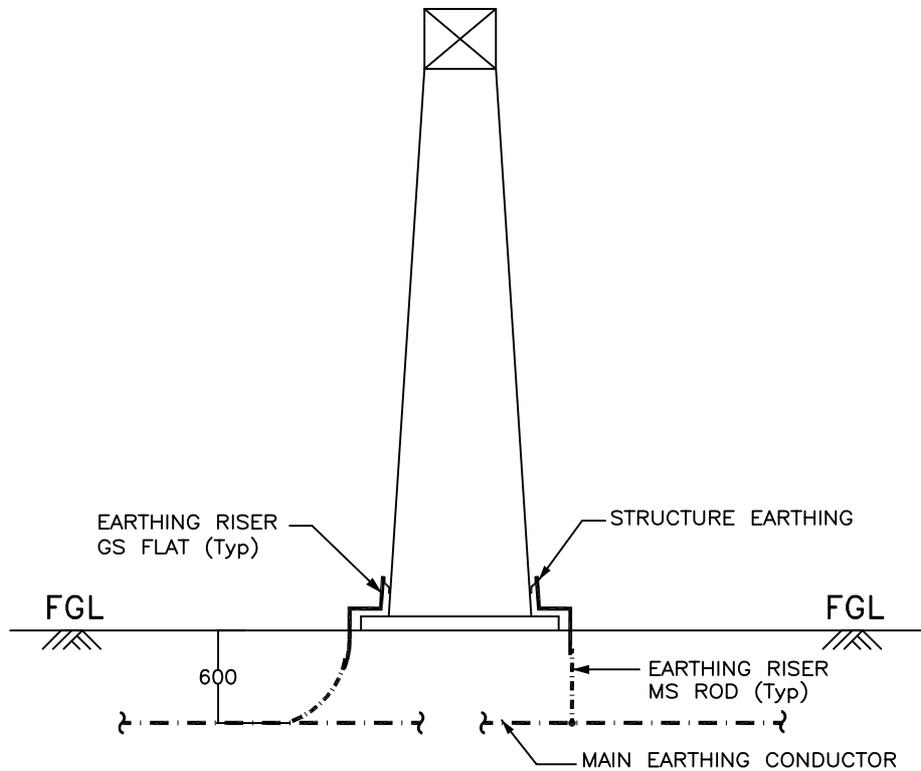


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>SK Parshar</i>	<i>SK Parshar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 19

EARTHING OF TOWER WITHOUT PEAK



ELEVATION

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

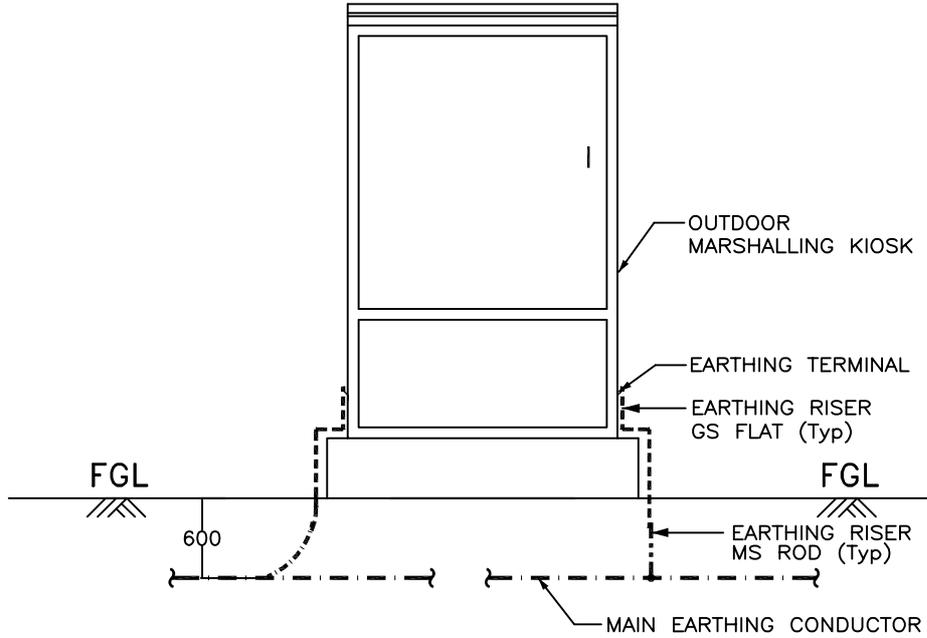
NOTES :-

1. No. OF RISERS = 2 Nos.

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>SK Parhar</i>	<i>SK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 20
CKD BY	PRPD BY	Date	

EARTHING OF BAY MARSHALLING BOX



ELEVATION

LEGEND

- · — · — · — 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

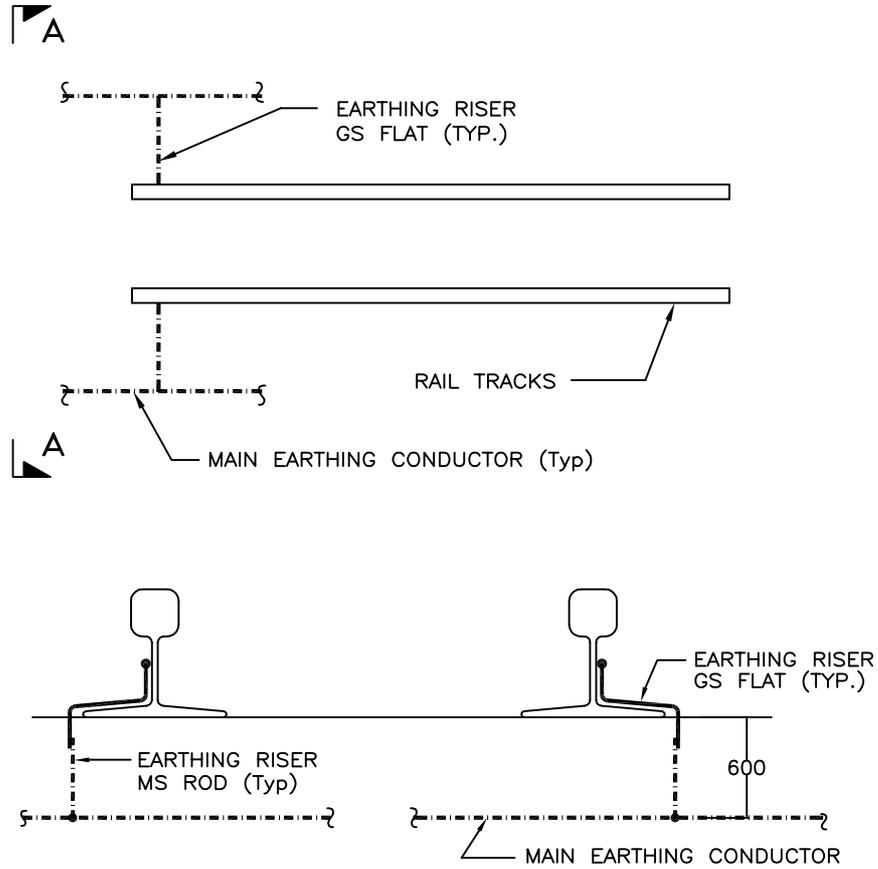
NOTE :-

1. No. OF RISERS = 2 Nos.

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>CKD</i>	<i>PRPD</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 21
CKD BY	PRPD BY	Date	

EARTHING OF RAIL TRACK



LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

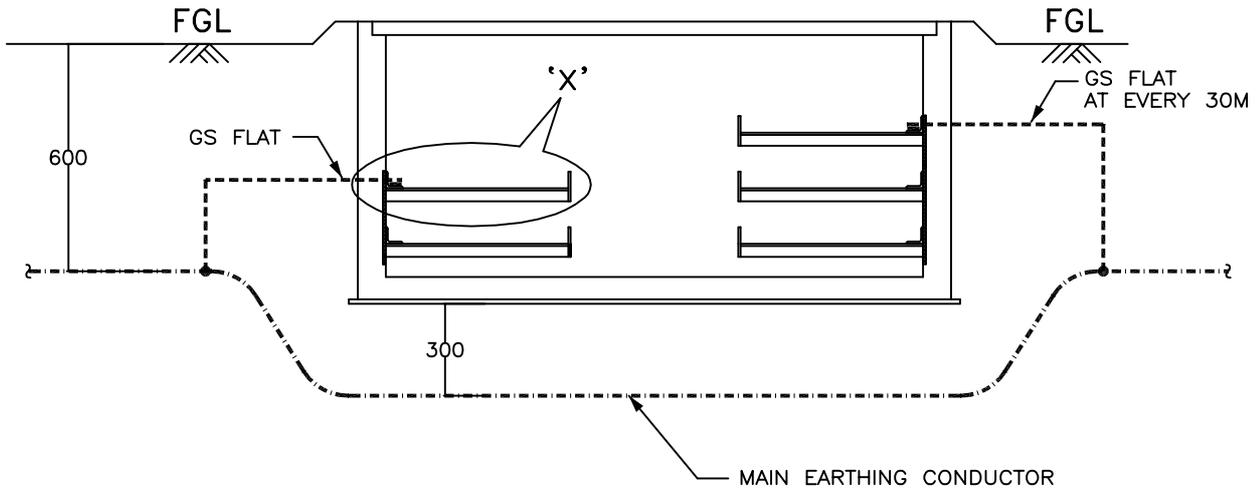
NOTES :-

1. EACH RAIL SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

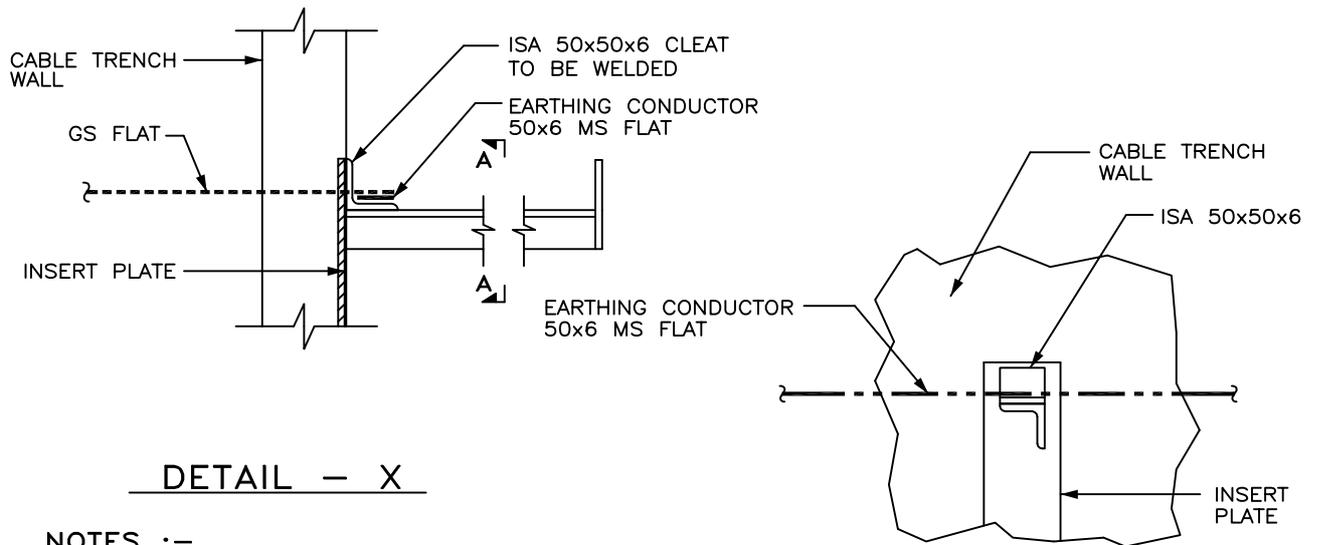
RELEASED FOR CONTRUCTION

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 22
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EARTHING OF CABLE TRENCH



TYPICAL CROSS SECTION OF CABLE TRENCH



DETAIL - X

SECTION A - A

NOTES :-

1. MS FLAT SHALL RUN ON TOP TIER ALL ALONG THE CABLE TRENCHES & WELDED TO EACH OF THE RACKS.
2. MS FLAT SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

RELEASED FOR CONTRUCTION

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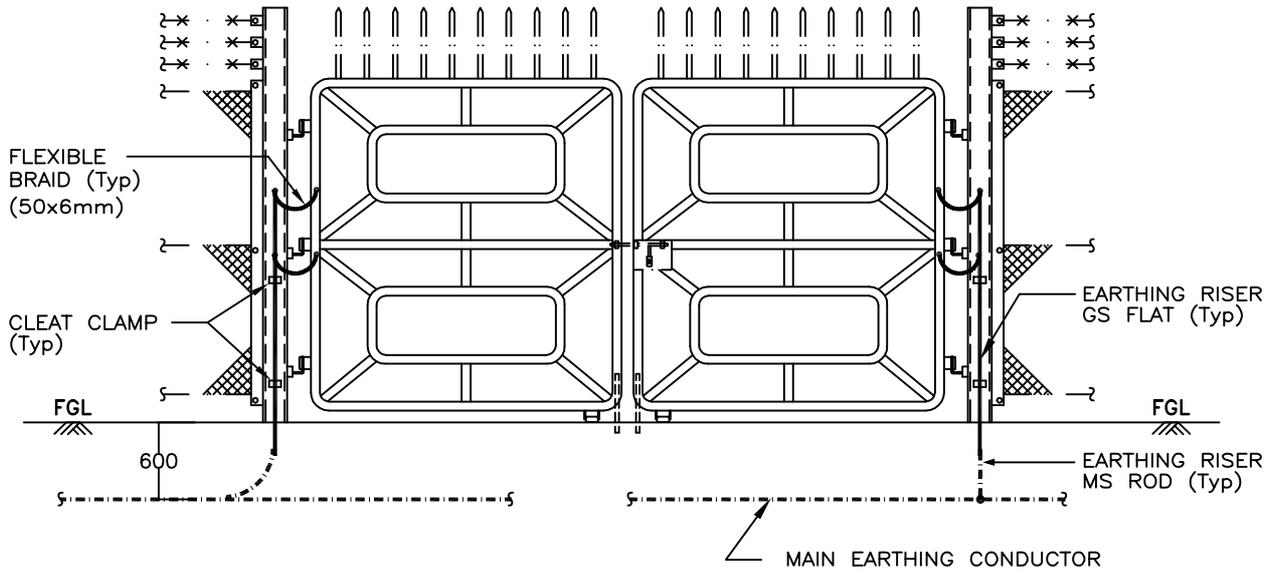


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>CKD</i>	<i>PRPD</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 23
CKD BY	PRPD BY	Date	

EARTHING OF GATES



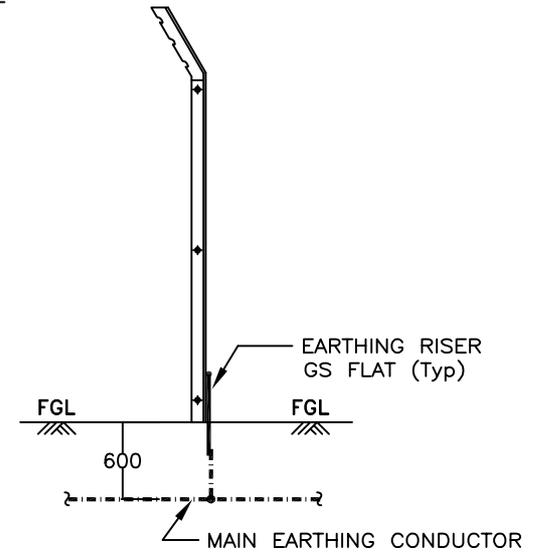
MAIN GATE

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm MS FLAT

NOTES :-

- | | | |
|---------------------------------------------------------------------------|-------------------|------------------|
| | FENCE POST | MAIN GATE |
| 1 . No. OF RISERS REQUIRED | 1 | 2 |
| 2 . No. OF FLEXIBLE BRAID | - | 4 |
| 3. ALL GATES & EVERY ALTERNATE FENCE SHALL BE CONNECTED TO EARTHING GRID. | | |

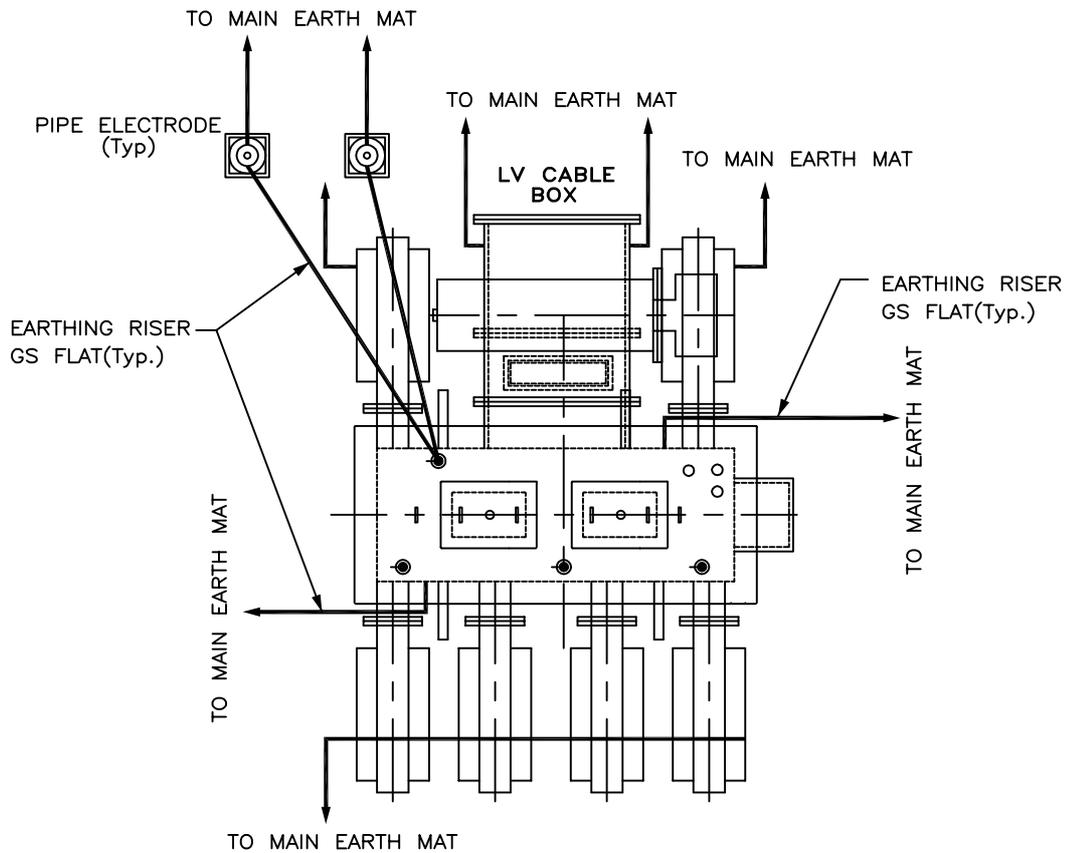


FENCE POST (ALTERNATE FENCE POST)

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
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CKD BY	PRPD BY	Date	

EARTHING OF LT TRANSFORMER



PLAN

LEGEND

— · — · — · —	40mm ϕ MS ROD
—————	75 x 12 mm GS FLAT
- - - - -	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS FOR MAIN TANK & T.M. MAR. BOX = 4 Nos.
2. No. OF RISERS FOR LV CABLE BOX & RADIATOR = 4 Nos.
3. No. OF RISERS FOR PIPE ELECTRODE = 2 Nos.
4. No. OF PIPE ELECTRODES REQUIRED = 2 Nos.

RELEASED FOR CONTRUCTION

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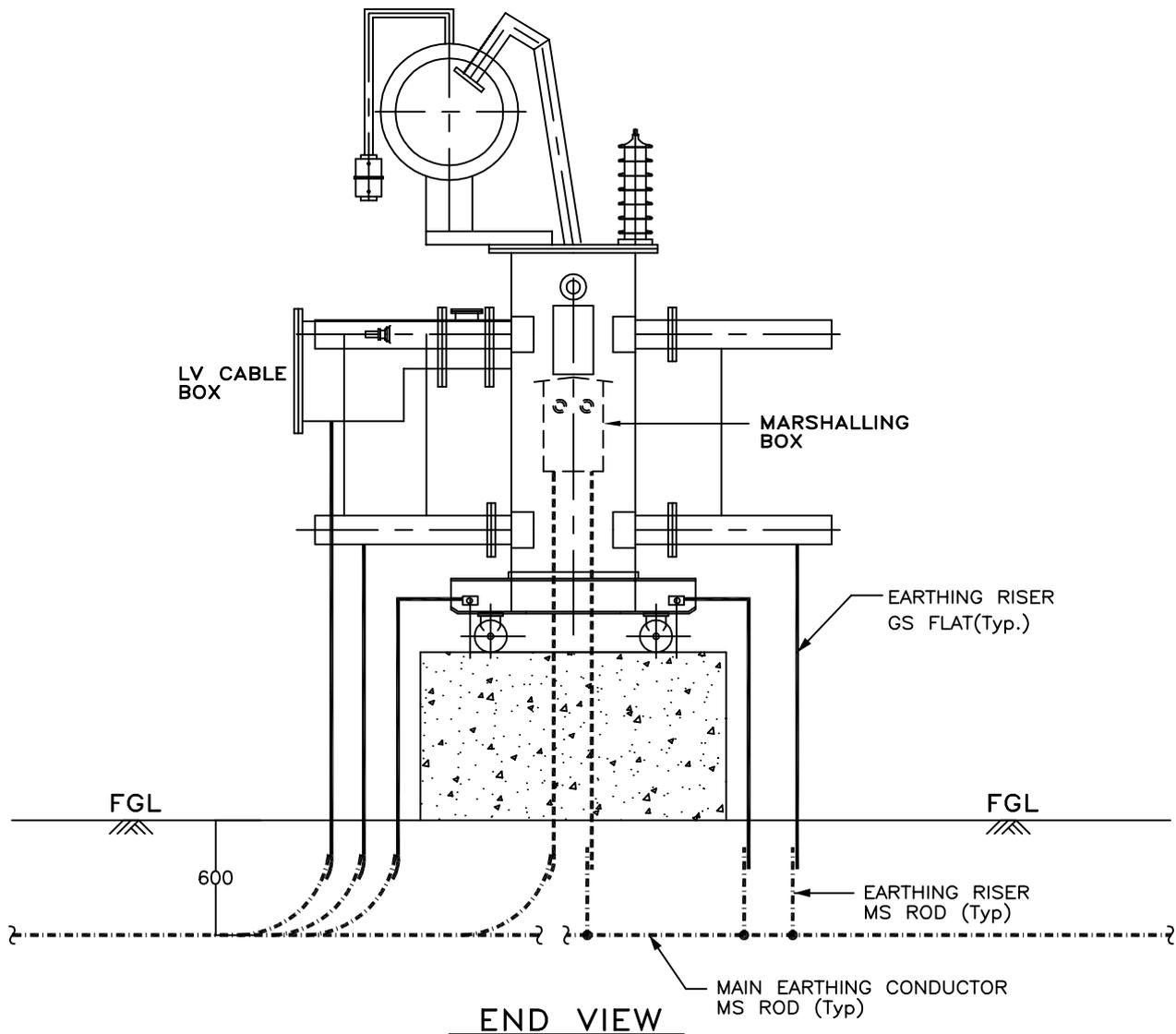


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parshar</i>	<i>KK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 25
CKD BY	PRPD BY	Date	

EARTHING OF LT TRANSFORMER



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**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 26
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EARTHING OF PYLON SUPPORTS

Pylon supports shall be grounded through 50x6mm GI flat to the ring around the Pylon supports of 75x12mm GI flat which in turn is connected to the main grid (40 mm dia MS rod) at 2 to 3 points as available.

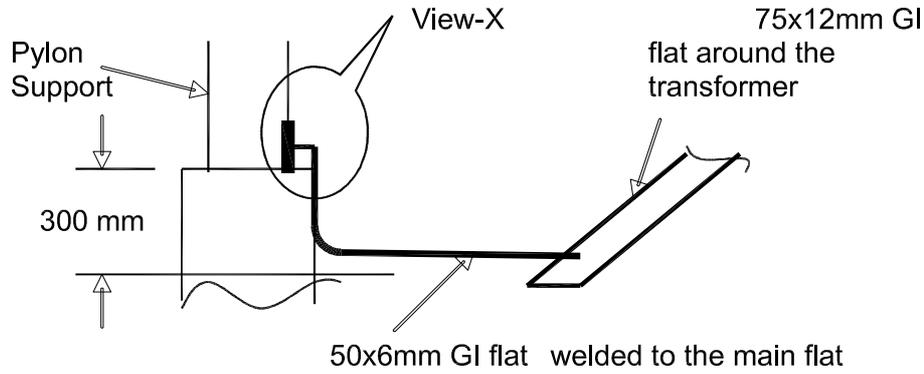


Fig.- Elevation (Earthing of Pylon Supports)

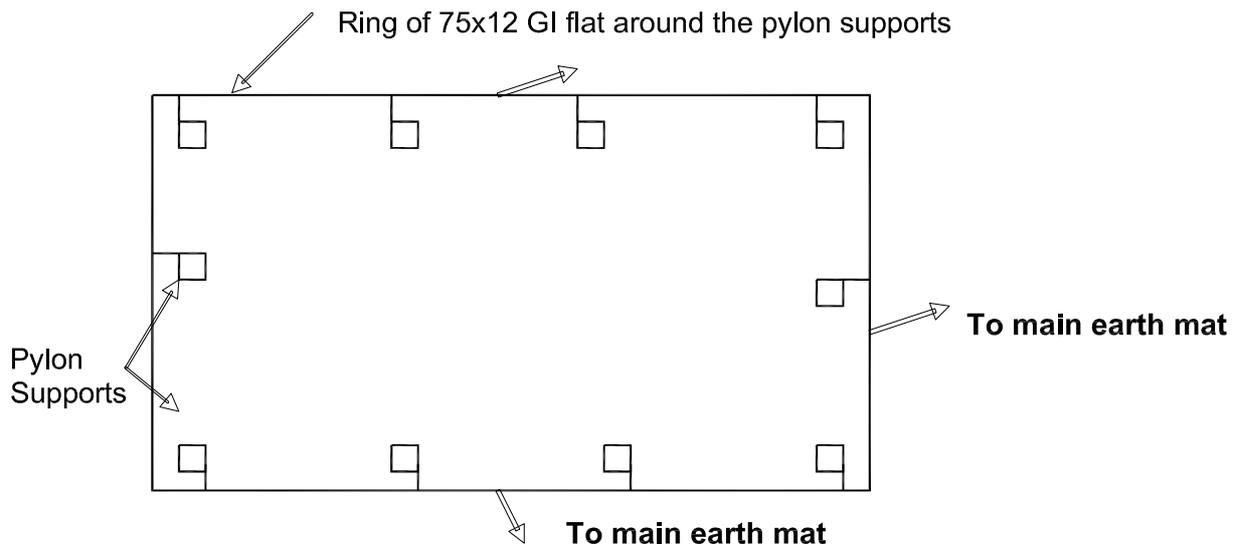


Fig.- Layout (Earthing of Pylon Supports)

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>HN Pashar</i>	<i>HN Pashar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 27
CKD BY	PRPD BY	Date	

EARTHING OF HYDRANT/ HVW SPRAY PIPING

These pipes shall be grounded at pump house through 50x6mm GI flat connected to the main flat, 75x12mm running around the room.

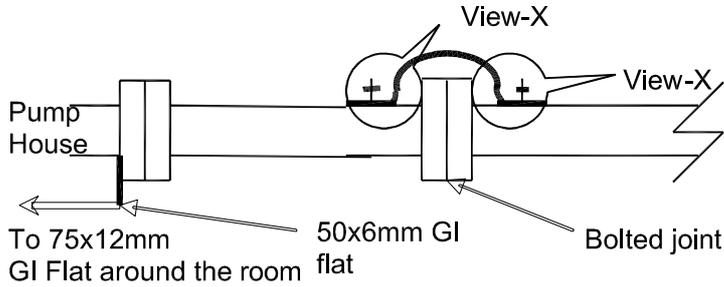


Fig.-Earthing of Hydrant / HVW Spray Piping

EARTHING OF HYDRANT POST/ HOSE BOX

A bolt shall be welded to these structures at the time of installation which can be used to connect them to the nearest riser or main 75x12mm GI flat through 50x6mm GI flat.

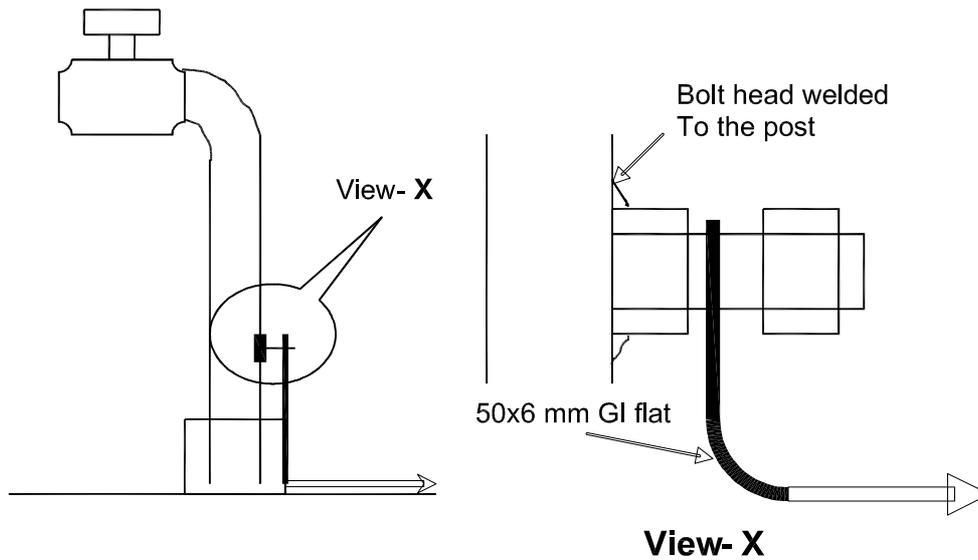


Fig.- Earthing of hydrant box / hose box

RELEASED FOR CONTRUCTION

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(A Government of India Enterprise)



PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>HN Pashar</i>	<i>HN Pashar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 28
CKD BY	PRPD BY	Date	

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PRE-COMMISSIONING CHECKS/TESTS FOR OTHER SWITCHYARD EQUIPMENTS

Once erection is completed, various pre-commissioning checks/ tests are performed to ensure the healthiness of the switchyard equipments prior to their energisation. Various major electrical tests to be performed and their significance are given below:

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.1	Tan δ & Capacitance measurement of CT, each stack of CVT & total capacitance, CB voltage grading capacitor & each stack of Surge Arresters	The purpose of the dissipation factor measurement of high voltage insulation is to detect incipient weaknesses in HV insulation. The most important benefit to be gained from this measurement is to obtain a “benchmark reference reading” on costly and high voltage equipment when the equipment is new and insulation is clean, dry and free from impurities. Tan delta & Capacitance values shall be comparable with factory test results and in no case shall be more than 0.5 %.
6.2	Checks/ Tests applicable for CTs	
6.2.1	Polarity test for CT	To ascertain whether the polarity markings are correct or not as per drawing.
6.2.2	Magnetization characteristics of CT	To prove that the turns of CTs secondary windings are not short circuited and to check healthiness of CT cores. The magnetizing currents at KPV (Knee point voltage) shall be less than the specified value. The ratio of secondary and primary voltage shall also be measured.
6.2.3	Ratio test for CT	The ratio errors of the primary to the secondary currents should within specified ratio errors.
6.2.4	IR measurement of CT (Primary & Secondary windings)	Changes in the normal IR value of CT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CT and degradation of insulation.
6.2.5	DGA test of CT oil	This test shall be conducted after 30 days of commissioning. The purpose is to identify evolving faults in the CT and DGA values shall be comparable with factory values (if available)
6.3	Checks/ Tests applicable for Circuit Breakers	
6.3.1	Dew point measurement of SF ₆ gas	Dew point of SF ₆ gas is to measure moisture content in SF ₆ gas which shall indicate whether CB evacuation is done properly or not. This test shall be carried out preferably at rated pressure of SF ₆ gas.
6.3.2	Measurement of Circuit	To measure closing/ tripping/ CO timings. These timings



Sr. No.	Name of Test / Check point	Purpose of test/ check
	Breaker Operating Timings including PIR Timings	should be within permissible limits and shall be comparable with factory values. Pole discrepancies and Break to Break discrepancies shall be less than specified values.
6.3.3	DCRM Contact Travel Measurement / DC injected currents and trip/ close coil currents.	DCRM is the technique for measuring Contact Resistance during operation (Close/ Trip) of a circuit breaker with a delay Tco of 300ms. A DC current of at least 100 Amp is injected through the circuit breaker. The current and voltage drop are measured and resistance is calculated. The resistance and travel versus time data provides useful information on the condition of the circuit breaker contacts and is used as a diagnostic tool. DCRM test signatures shall be approved by Corporate OS.
6.3.4	Operational lockout checking for EHV Circuit Breakers	To ensure various lockout operation of CB by simulating the actual conditions at the specified pressure of oil/ air/ operating medium.
6.3.5	Measurement of static contact resistance	This test is conducted to evaluate healthiness of Main contacts. 100 Amp DC is injected and voltage drop is measured across each CB contact to compute contact resistance.
6.3.6	Checking the Anti-Pumping feature	By giving simultaneous close/ trip commands, CB hunting shall not take place by operation of Mechanical/ Electrical anti pumping feature.
6.3.7	Checking the Anti-Condensation Heaters	To check correct operation of Thermostat provided for anti condensation heaters.
6.3.8	Pole discrepancy relay testing	To test tripping of CB in case of pole discrepancy more than 2.5 seconds or specified value.
6.3.9	Checking the N2 priming pressure	This test is to check healthiness of N2 accumulators provided in Hydraulic drive mechanisms. N2 priming pressure shall be as per the rated pressure.
6.4	Checks/ Tests applicable for CVTs	
6.4.1	CVT polarity, Ratio test	This test is conducted in the same manner as for CT to determine correct CVT polarity, ratio and phasor group.
6.4.2	Insulation resistance measurement of Primary & secondary winding	Changes in the normal IR value of CVT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CVT and degradation of insulation.
6.5	Checks/ Tests applicable for Isolators	
6.5.1	MILLIVOLT Drop test	The voltage drop gives a measure of resistance of current carrying part and contacts by injecting minimum 100 A DC current.

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.5.2	50 operation tests	To test operation of contacts etc with jumpers connected and contact resistance to be measured after 50 operations. There shall not be any change from the previous value.
6.6 Checks/ Tests applicable for Surge Arrestors		
6.6.1	Third Harmonic Resistive Current (THRC) for surge arrestors	To monitor healthiness of Surge arrestors by monitoring third harmonic resistive current from the leakage current. This test is to be conducted after charging of Las. The value of THRC shall be less than 30 μ A.
6.6.2	IR measurement of each stack of LA	Changes in the normal IR value of LA indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of LA and degradation of insulation.
6.6.3	Checking of operation of LA counter	This test is done to check the healthiness of LA counter.
6.7 Checks/ Tests for other areas/ equipments		
6.7.1	Earth resistance measurement	To ensure value of earth resistance is below 1 ohm.
6.7.2	Secondary current injection test	Conducted for testing of protecting devices, circuit breakers, trip coils, motor overloads etc.
6.7.3	Contact Tightness check of Bay contacts by Primary injection method	Since complete bay contact resistance measurement is practically not possible because DC current may not be injected in CT primary, hence contact tightness check by primary injection method has been introduced to check overall contact tightness.
6.7.4	Stability check for Bus Bar	This test is performed to check the proper operation of Bus Bar protection by simulating actual conditions. Any problem in CT connection, wrong cabling, relay setting can be detected by this test.



6.1 TAN DELTA & CAPACITANCE MEASUREMENT OF CT, CVT, CB VOLTAGE GRADING CAPACITORS AND LA STACKS

To measure dissipation factor/loss factor (Tan delta) and Capacitance measurement of EHV class CTs, CVTs, CB Voltage Grading Capacitors & LA stacks by applying test voltages up to 10kV.

A) CURRENT TRANSFORMERS

CTs with test taps

1. Tan delta tap to be disconnected from ground.
2. High voltage lead from tan delta kit to be connected to primary(HV) Terminal and LV lead to be connected to the Tan delta test tap.
3. P1 and P2 to be shorted
4. Porcelain surface to be thoroughly cleaned.
5. Measurements have to be taken in UST mode with fully automatic test kit.
6. Standard procedure(as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed for measurement of capacitance and tan delta values.
7. It is to be ensured to connect the test tap to ground terminal after carrying out the test.

B) CB VOLTAGE GRADING CAPACITOR

1. Connect LV cable to the middle of the double interrupter.
2. Connect HV cable to the other end of the Grading capacitor to be tested.
3. The opposite end of the grading capacitor has to be grounded using earth switch.
4. Measurements have to be taken in UST Mode with fully automatic test kit.
5. Disconnect the HV cable and connect the same to the other grading capacitor and ground the previous grading capacitor. Now the second grading capacitor is ready for testing.
6. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed
7. Measurements are to be carried out at 10 kV/ 12 KV.

C) CAPACITOR VOLTAGE TRANSFORMERS

1. Testing procedure for Top and Middle Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV
 - (c) While measuring Middle/ Bottom stacks, Top/ middle stacks to be shorted.
2. Testing procedure for Bottom Stack connected to EMU PT
 - (a) Connect HV of the test kit at the top flange of bottom stack. HF point to be grounded. Earth connection of the neutral of the PT to be opened/ isolated from ground.
 - (b) Top of CVT to be guarded. LV lead of the kit to be connected at the top of the CVT for guarding.

- (c) Carry out measurements in GSTg mode at 10.0 KV
 - (d) Repeat the Test with neutral of PT connected to ground.
 - (e) In case Tan delta value is negative or erratic, only capacitance values are to be monitored.
 - (f) Measurement to be carried out using fully automatic kit.
3. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.

D) SURGE ARRESTERS

1. Testing procedure for Top, Middle and Bottom Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle/ Bottom stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV with fully automatic test kit.
 - (c) While measuring Middle/ Bottom stacks, the stacks above the HV lead to be shorted.
2. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.
3. While doing measurement of bottom stack the earth connection to be removed.

6.2 CHECKS/TESTS APPLICABLE FOR CTs

6.2.1 POLARITY TEST FOR CT

A centre zero voltmeter is connected across CT secondary. A 1.5 Volt battery is touched to primary of CT. The deflection of pointer should be similar in case of each CT core.

At any instant current entering the primary from P1 the current should leave secondary from the terminal marked S1. A setup shown in the Figure 9 can show whether the polarity markings are correct or not.

When the key is pressed, current enters the primary through terminal P1, the voltmeter connected as shown, should read positive. A general arrangement of polarity test setup is indicated in Fig. 10.

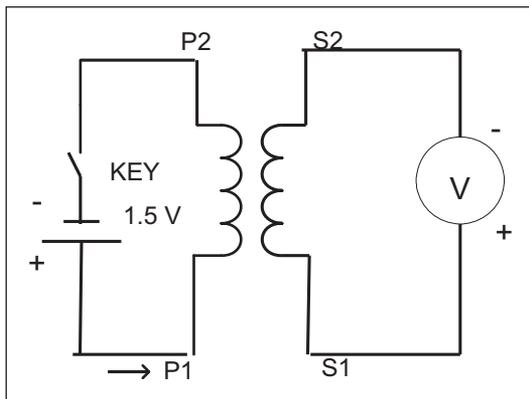


Figure - 9

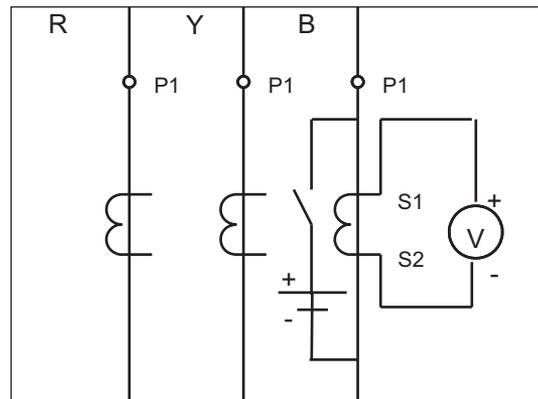


Figure - 10

6.2.2 MAGNETIZATION CHARACTERISTICS OF CTs

PRECAUTIONS

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.

Test Equipment: Voltage source of 5 kV, Voltmeter of range 0 to 5 kV, Ammeter of range 0 to 500 Amps, testing leads/cables etc.

Test Procedure: Make connections as per diagram shown below (Fig- 11). After making proper connections, applied voltage is increased from zero to rated Knee Point Voltage in steps of 25%, 50%, 75% and 100%. Measure the current drawn by the CT secondary core at respective applied voltages and record the test results

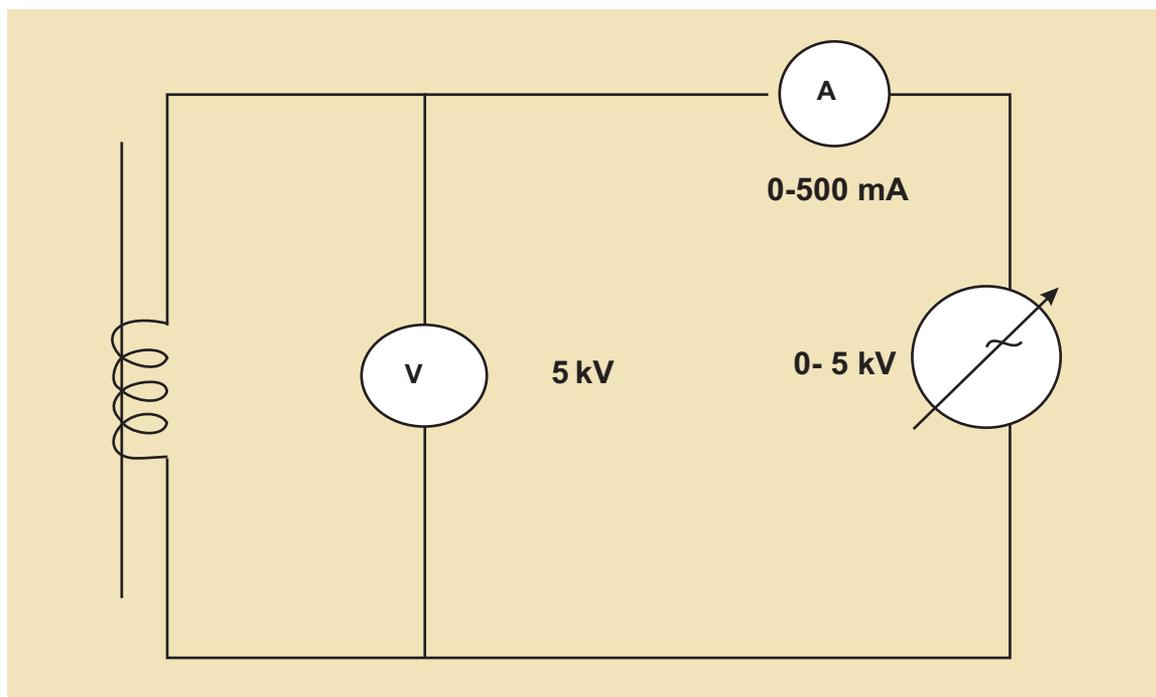


Figure - 11

Knee Point Voltage is normally defined as the voltage at which 10% increase in the applied voltage causes 30 to 50% increase in secondary current. The magnetization current at rated Knee Point Voltage should not be more than the specified/designed value. A curve can be drawn between applied voltage and magnetizing current. Typically, the curve drawn should be like the one given below in Fig.-12.

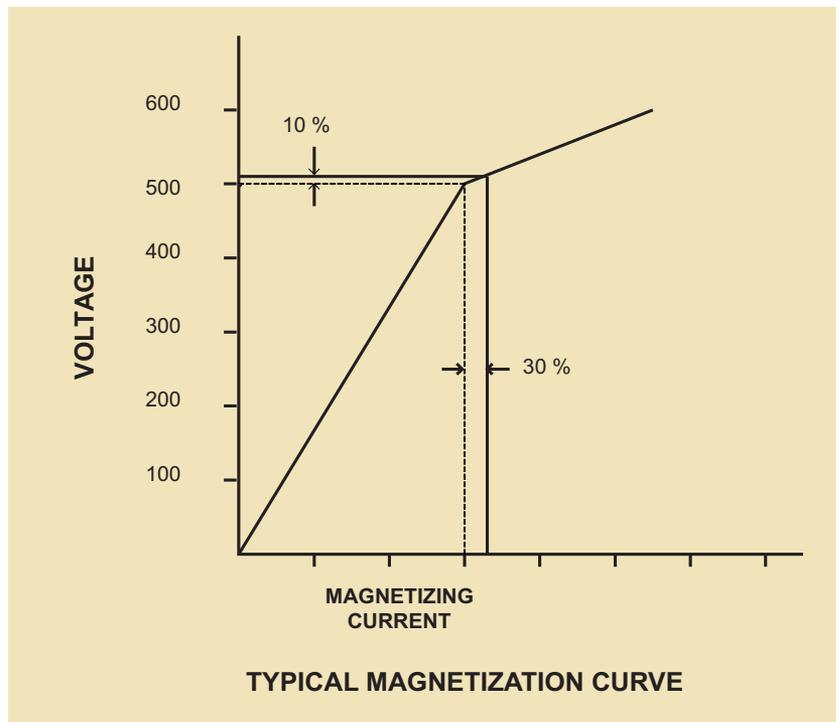


Figure - 12

From the curve it can be implied that up to rated KPV (Knee Point Voltage), the VI curve should be almost a straight line. However, if this line is not linear, this indicates that the magnetizing characteristics are not desirable. If the slope of the curve starts increasing, it indicates that magnetizing induction becomes low and total primary current is utilized in exciting the core alone. Consequently, out put of CT secondary disappears.

6.2.3 RATIO TEST FOR CURRENT TRANSFORMER

The ratio check has to be carried out as indicated in Fig-13 below.

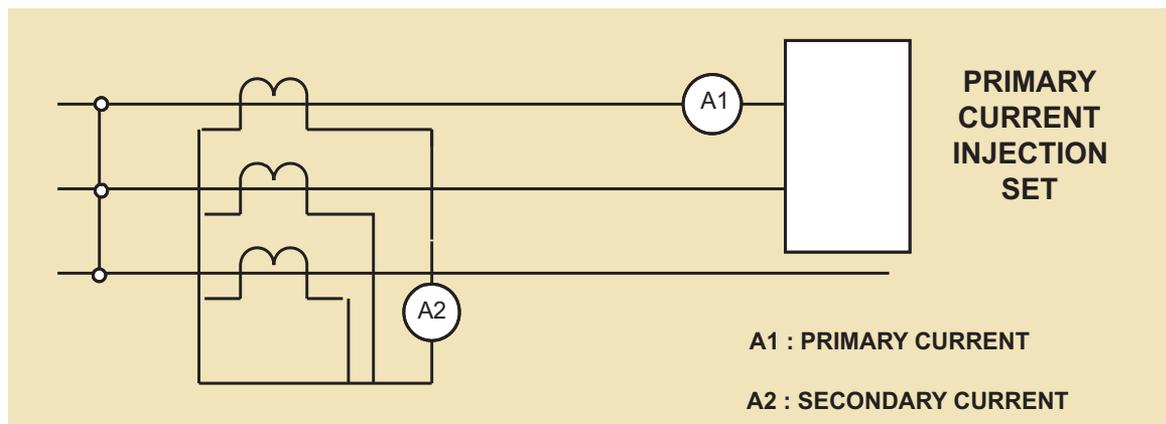


Figure - 13

It is customary to conduct this in conjunction with the primary injection test. Current is passed through the primary circuit with the secondary winding circuit to its normal circuit load. The ratio of the primary to the secondary currents should approximate closely to that stamped under CT identification plate.

Alternatively, ratio test is to be conducted as per the following method (Fig-14).

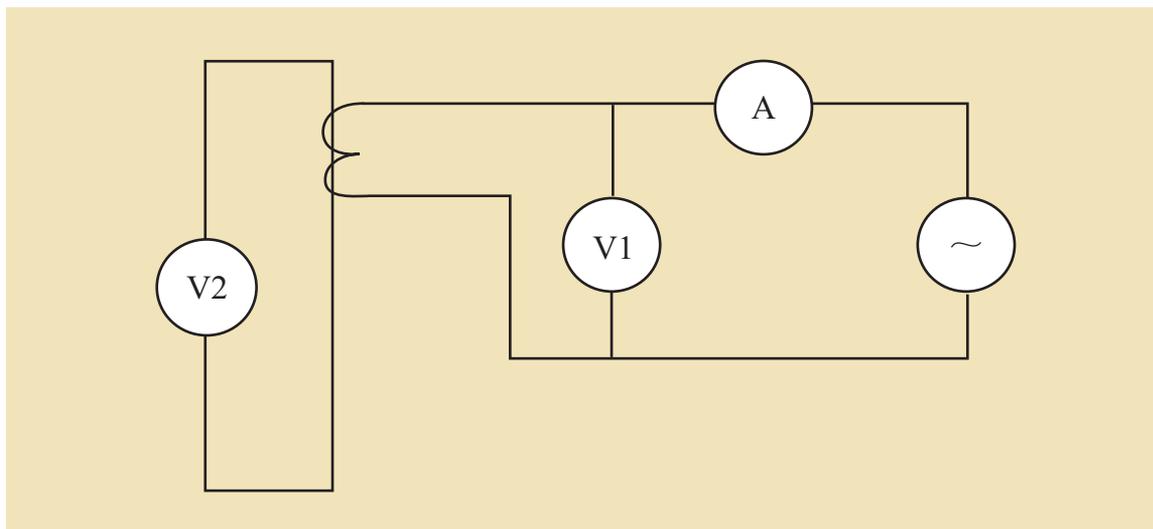


Figure - 14

Apply voltage from secondary of the CT and measure voltage in primary winding. Increase voltage in secondary up to rated KPV/ ISF and by recording Primary Voltage, compute ratio of $V1/V2$. The ratio should match with the specified value.

6.2.4 INSULATION RESISTANCE MEASUREMENT OF CURRENT TRANSFORMER

PRECAUTIONS

- a) There should be no joints in testing cables.
- b) Test leads should not touch any live part.
- c) Megger body should be earthed (if separate terminal is provided).
- d) Surface/terminals should be cleaned.
- e) IR measurement should be carried out preferably in dry and sunny weather.
- f) Never connect the test set to energized equipment.
- g) The ground terminal must be connected first and removed at last.
- h) High voltage plugs should be free from moisture during installation and operation.
- i) If oil traces are found on the surface of CT, the same should be cleaned by Methyl Alcohol only. Petrol or diesel should never be used.
- j) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing engineer only.
- k) After testing with high voltage, test terminals must be grounded before being touched by any personnel.
- l) Test leads should be properly screened/ shielded.

Connect the Megger as per figure-15 given below. Connect the HV terminal to the Primary terminal of CT by using crocodile clip for firm grip

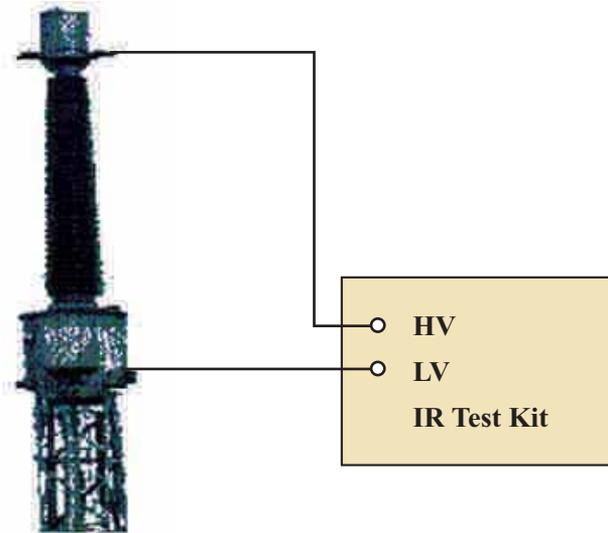


Figure-15 Typical Arrangement for IR measurement

Carry out the measurement as per standard procedure given by the kit supplier.

A test voltage as specified is applied as per the above connections and successive readings are taken. Values of IR should be recorded after 15 seconds, 60 seconds and 600 seconds. Ambient temperature and weather conditions are to be recorded.

6.2.5 DGA Test of CT Oil: Oil samples to be collected in 300ml bottles and to be sent to CIOTL Hyderabad for testing. Test results should be comparable to factory values. In case of any deviation, test results to be forwarded to CC-OS for approval.

6.3 CHECKS/TESTS APPLICABLE FOR CIRCUIT BREAKERS

6.3.1 DEW POINT MEASUREMENT OF SF₆ GAS FOR CIRCUIT BREAKER

Dew Point is the temperature at which moisture content in SF₆ gas starts condensing.

Dew Point at rated pressure of CB: Dew Point when measured keeping regulating valve in service at the outlet of dew point kit to allow required flow rate of gas, is called at rated pressure of CB. Inlet valve is opened completely.

Dew Point at atmospheric pressure : Dew Point when measured by regulating the gas flow at the inlet of dew point kit and keeping outlet regulating valve (if provided) in fully open condition so that flow rate of gas is maintained as required, is called at atmospheric pressure.

TESTING PROCEDURE

- Make the connections to the kit from CB pole ensuring that regulating valve is fully closed at the time of connections of the Dew Point kit.
- By regulating the flow rate of SF₆ gas (0.2 liter/min to 0.5 liter/min - ref. IEC 60480), the value of dew point is observed till it becomes stable.

- c) If the regulating valve is provided at outlet of the dew point kit then values as given in Doc. no. for rated pressures are to be monitored.

Dew Point of SF₆ gas varies with pressure at which measurement is being carried out. This is due to the fact that Saturation Vapour Pressure decreases with increase in Pressure of the SF₆ gas. Hence, dew point of SF₆ gas at higher pressure is lower than dew point at atmospheric pressure. Therefore, it is to be ensured that if measurement has been done at a pressure other than the atmospheric pressure, same is to be converted to the atmospheric pressure as given in the table below used at the time of commissioning for various CB manufacturers: Method for converting dew point at different gas pressures, is given/described in IEC-60480.

Sl. No.	Make of CB	Dew point at rated pressure	Dew point at Atmospheric Pressure (Limit)
1	BHEL	(-) 15° C	- 36° C
2	M & G	-	- 39° C
3	CGL	(-) 15° C	- 35° C
4	ABB	(-) 15° C	- 35° C
5	NGEF	(-) 15° C	- 36° C

6.3.2 MEASUREMENT OF CIRCUIT BREAKER OPERATING TIMINGS INCLUDING PRE INSERTION RESISTOR TIMINGS

PRECAUTIONS

- There should not be any joint in testing cables.
- Test leads should not touch any live part.
- Never connect the test set to energised equipment.
- The ground cable must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- Circuit Breaker Analyser body should be earthed (if separate earth is provided).
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- Surface/terminals should be cleaned where the connections for testing are to be made.
- Clean earth point with sand paper/wire brush where earth terminal is to be provided.
- Ensure that all the poles trip simultaneously through single close/trip command.

TESTING PROCEDURE

- Make connections as shown in the figure-16 below. It is to be ensured that R, Y, B phase marking cables are connected with the proper place in the CB analyser and colour codes are to be maintained for all the three poles of CB.
- Make connections for recording operating timings of Auxiliary contacts.
- Extend power supply to Circuit Breaker Analyzer.
- Give closing command to closing coil of CB and note down the PIR and main contact closing time. Take the print out from the Analyzer.

- e) Give tripping command to trip coil-I of CB & note down the main contact tripping time.
- f) Give tripping command to trip coil-II of CB & note down the main contact closing time.
- g) Note down the timings for 'CO', and 'OCO' by giving respective commands. CO command to be given without time delay but 300ms time delay to be given between O and CO operation in testing for OCO.
- h) To find out opening time of PIR contacts, PIR assembly has to be electrically isolated from Main contacts and then PIR contacts are to be connected to separate digital channels of the Analyzer.

EVALUATION OF TEST RESULTS

A) CLOSING TIMINGS

Closing timings and Discrepancy in operating times of PIR and main contacts should not exceed the permissible limits as specified in the DOC NO: D-5-02-XX-01-03. In any case, main contacts should not close prior to closing of PIR contacts and PIR contacts should not open prior to closing of main contacts. In case, contact bouncing is observed in operating timings for PIR and main contacts, same should be rectified by tightening the cable connections.

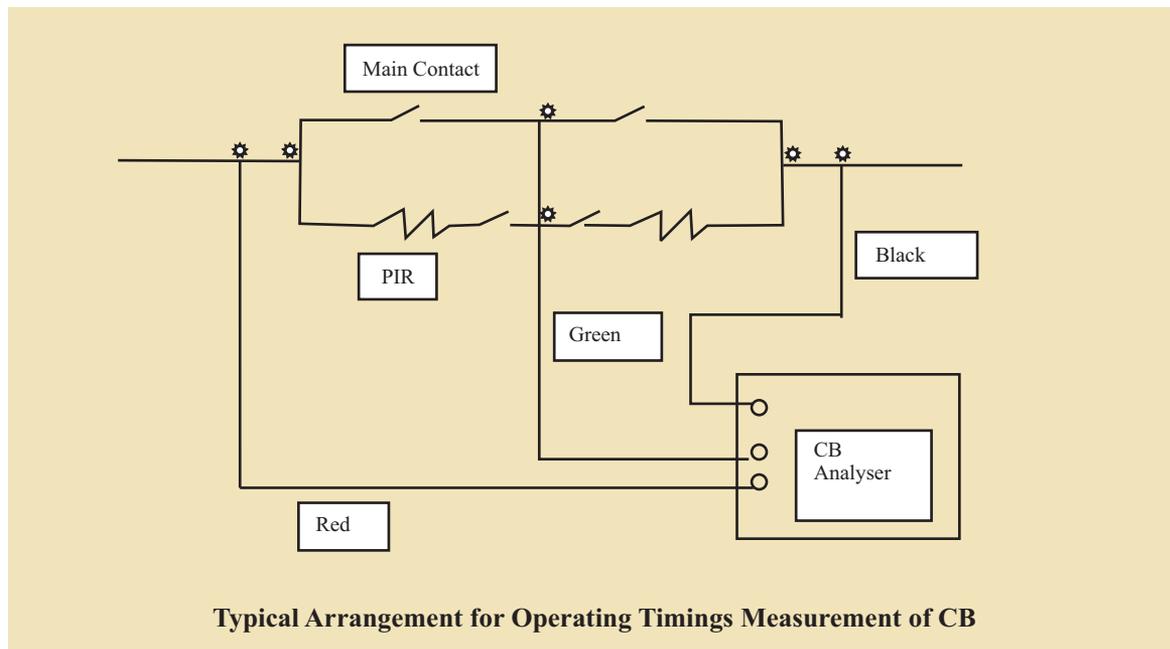


Figure - 16

B) TRIPPING TIMINGS

Trip time and pole discrepancy in operating timings should not exceed beyond permissible value given in Doc. No. D-5-02-XX-01-03. In case of ABB, NGEF and CGL make CBs, while tripping, PIR contacts should not open after opening of main contacts.



C) 'CO' TIMINGS

CO timings should be within permissible limits as specified by different manufacturers. If operating timings of CB poles are not within limits, same may be corrected by:

1. Equalizing the SF6 gas pressure in all the poles
2. Adjusting plunger movement of trip/ close coils
3. Adjustment in operating mechanism
4. Changing of trip/ close coils (if required)

It is also important to measure timings of auxiliary contacts from the point of view of variations w.r.t. the main contacts.

6.3.3 DYNAMIC CONTACT RESISTANCE MEASUREMENT (DCRM) AND CONTACT TRAVEL MEASUREMENT OF EHV CIRCUIT BREAKERS

Test Equipment: 100 Amp. DCRM kit with CB operational analyzer with 10k Hz sampling frequency.

Isolation Required

- a) CB should be in open position.
- b) Isolator of both sides of CB should be in open position.
- c) Earth switch of one side of CB should be in open position.

Precautions

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- c) Current leads should be connected such that voltage leads are not outside area of current flow.

Testing Procedure

1. Follow the standard procedure as given in instruction manual of DCRM kit.
2. The tightness of connections at CB flanges is most important to ensure error free measurement. CB during CO operation generates lot of vibrations and failure of connections during this period can dramatically change the dynamic signature of CB resistance.
3. DCRM signatures should be recorded for CO operation. Open command should be extended after 300 ms from the close command.
4. Clean portions of incoming and outgoing flanges of CB with polish paper to remove paint, oxidation etc, at points where Current clamps are mounted.
5. Select this point of connection, as close as possible to the end of porcelain insulator to ensure that minimum resistance is offered by flanges, bolts, terminal connectors etc.
6. It should be ensured that Travel Transducers are properly fitted.
7. Sampling frequency during measurement should be 10 KHz.
8. Resistance, travel, injected current and Trip/ Close coil currents are to be recorded.

The variations in the measured resistance versus time will be seen as a finger print for the breaker contacts and can be used as a bench mark for comparing with future measurements on the same breaker. This provides information on the condition of the breaker contacts, driving mechanism, operating levers etc.

Dynamic Contact Resistance Measurement for CB healthiness

By application of Dynamic Contact Resistance Measurement, condition of arcing contact, main contact, operating levers, driving mechanism can be predicted. If DCRM signature shows wide variations and also there is change in arcing contact insertion time, it indicates erosion of the arcing contacts to main contacts and subsequent failure.

Contact Travel Measurement

Transducers are attached to the operating rod or interrupting chamber in order to record the contact travel. When CB closes, contact travel is recorded. Contact bounces or any other abnormality is also clearly indicated by the Contact Travel Measurement.

If contact travel, contact speed and contact acceleration signature are compared with the original signatures, then it may indicate problems related with the operating mechanism, operating levers, main/ arcing contacts, alignments etc.

DCRM along with Contact Travel measurement is useful in monitoring length of Arcing contacts. Erosion of Arcing contacts may lead to commutation failures and current may get transferred to Main contacts. Due to heat of arc, main contacts may get damaged.

6.3.4 OPERATIONAL LOCKOUT CHECKING FOR EHV CIRCUIT BREAKERS

6.3.4.1 TESTING PROCEDURE:

A. SF₆ GAS PRESSURE LOCKOUT

a) LOW PRESSURE ALARM

Close Isolation Valve between CB Pole(s) and density monitor. Start releasing SF₆ gas from density monitor till the low pressure gas alarm contacts are actuated which is detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated.

b) OPERATIONAL LOCKOUT:

Continue releasing SF₆ gas from isolated zone till the operational lockout Alarm Contacts are actuated which are detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated. This is called operational lockout pressure.

B. PNEUMATIC OPERATING SYSTEM LOCKOUT

a) COMPRESSOR START/STOP SWITCH

Close the isolating valve of CB. Release air into atmosphere from the compressor. Note down the value of pressure at which Compressor starts building up air pressure and pressure at which Compressor stops.



b) CBAUTO RECLOSE LOCKOUT

Close isolation valve between pneumatic system and pressure switches. Release air from the isolated zone to atmosphere. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter. The leads of the Multimeter should be connected to the contactor where the ARL/O of CB are made.

c) CB CLOSING LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

e) MECHANICAL CLOSING INTERLOCK (FOR ABB & BHEL CBs ONLY)

CB should be in closed position. Release air from pneumatic system of CB to atmosphere and observe whether CB poles start opening, if so, note down the pressure at which tie rod starts coming down. In such case the closing interlock is to be opened for inspection and if required, replace the closing interlock.

C. HYDRAULIC OPERATING SYSTEM LOCKOUT

a) Pump START/STOP

By opening pressure release valve, note down the pressure at which Pump starts building up oil pressure and pressure at which pump stops.

b) CBAUTO RECLOSE LOCKOUT

Close Isolation valve between hydraulic system and pressure switches. Release oil from the isolated zone to oil tank. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter.

c) CB CLOSING LOCKOUT

Release oil from the isolated zone to oil tank. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release oil from the isolated zone to container. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

D. OPERATING PRESSURE DROPTEST:

For Pneumatic/ Hydraulic operating system, operating pressure drop test to be performed during OCO operation of CB, keeping AC supply of Hydraulic pump/ Compressor in off condition. Hydraulic/ Pneumatic pressure drop should be within limits (as recommended by Manufacturer)

6.3.4.2 EVALUATION OF TEST RESULTS

A. SF6 GAS PRESSURE LOCKOUT

All the SF6 gas pressure switches settings should be checked and corrected with ambient temperature. Settings of SF6 gas pressure switches should be within ± 0.1 bar/ Kg/cm² of the set value (after taking into account the temperature correction factor).

B. AIR PRESSURE LOCKOUT

All the air pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

C. OIL PRESSURE LOCKOUT

All the oil pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

6.3.5 MEASUREMENT OF STATIC CONTACT RESISTANCE

The Static contact resistance of main circuit of each pole of a circuit breaker is of the order of a few tens of micro ohms. 100 A DC is injected and milli volt drop is measured across each CB contact to compute contact resistance. The values should be within specified limits.

6.3.6 CHECKING THE ANTI-PUMPING FEATURE

When the breaker is in open position and closing and opening commands are given simultaneously the breaker first closes and then opens, but does not reclose even though the closing command is maintained.

6.3.7 CHECKING THE ANTI-CONDENSATION HEATERS

Check the supervisory circuit of the anti-condensation heaters for correct functioning. With the heaters switched ON, measure their current output.

6.3.8 POLE DISCREPANCY RELAY TESTING

Pole Discrepancy is defined as the difference in closing & opening timings of different poles of CB.

A. WHEN CB IN OPEN POSITION

Closing Command is extended to close one pole, say R-Pole, of CB. After closing R-Pole of CB, this Pole should automatically open after 2.5 seconds (as per pole discrepancy timer settings). Repeat the test for remaining two poles of CB.

B. WHEN CB IN CLOSED POSITION

Tripping Command is extended to trip one pole, say R-Pole, of CB. Remaining Y and B- Poles of CB should automatically open after 2.5 seconds. Repeat the same test for remaining two poles of CB.

C. EVALUATION OF TEST RESULTS

Permissible value of pole discrepancy between two poles of CB is 3.33 msec. from system point of view and it should not be confused with the setting of pole discrepancy timer which is generally 1.0 or 2.5 sec. depending on Auto-reclose scheme.

6.3.9 CHECKING THE NITROGEN PRIMING PRESSURE

Close the pressure release valve. Shortly after the oil pump starts, the priming pressure (200 bar at 20 °C) in the accumulator can be read. The relationship between the pressure and temperature is indicated in Fig. 17.

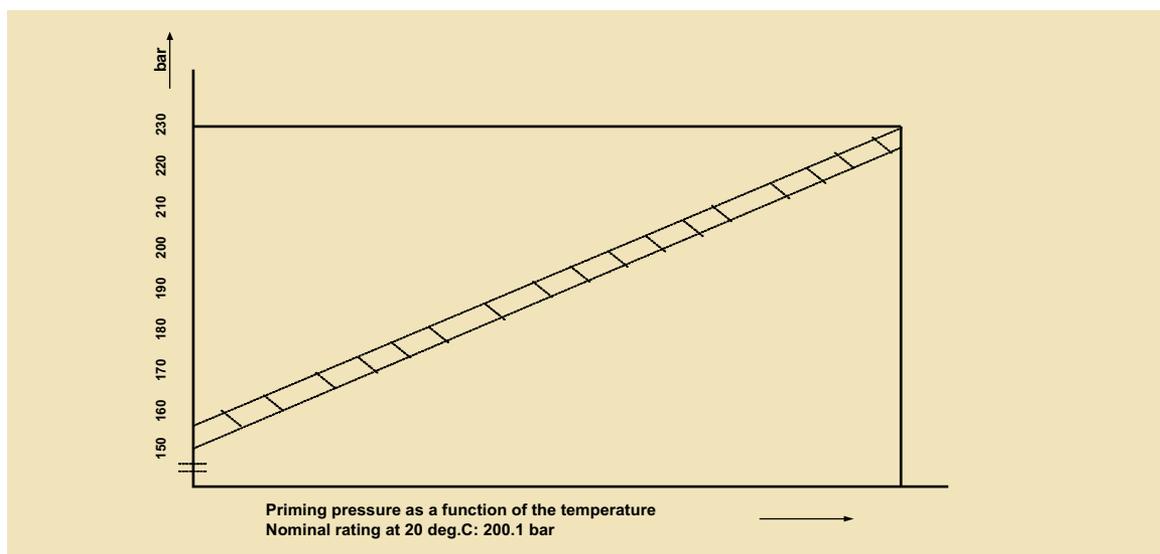


Figure - 17

6.4 CHECKS/TESTS APPLICABLE FOR CVTs

6.4.1 CVT POLARITY, RATIO TEST

CVT polarity is checked in the same manner as for CT, taking care to ensure that the battery is connected to the primary winding. In case of star/star winding configuration care has to be taken to ensure that the primary and secondary neutral points are not connected together. It is necessary to verify that the phase rotation sequence of the 3 phase CVT is correct. The secondary voltage between phases and neutral are measured and then phase rotation meter is connected across the three phase terminal.

6.4.2 INSULATION RESISTANCE MEASUREMENT OF PRIMARY & SECONDARY WINDING

6.5 CHECKS/TESTS APPLICABLE FOR ISOLATORS

6.5.1 MILLIVOLT DROP TESTS

The milli volt drop across the isolator is measured using DC current. The voltage drop gives a measure of resistance of current carrying part and contacts.

The DC current should be equal to or more than 100 A. The resistance of isolator should be measured at ambient air temperature. The temperature of specimen/environmental temperature should be recorded. The value of measured resistance should be converted to the value of temperature at which factory test results are taken. Temperature corrected value of resistance should be comparable to the factory value.

6.5.2 50 OPERATION TESTS

6.6 CHECKS/TESTS APPLICABLE FOR SURGE ARRESTERS

6.6.1 MEASUREMENT OF THIRD HARMONIC RESISTIVE CURRENT FOR SURGE ARRESTERS

Testing Procedure

- Make the connections as per the diagram given below (Fig.18)
- The kit should be properly earthed.
- Clamp On type CT should be placed above the surge monitor to pick up the total leakage current.
- Carryout the measurements as per standard procedure supplied by the test kit manufacturer.
- Note down the system voltage and ambient temperature along with the test current value.
- Avoid measurement during monsoon.

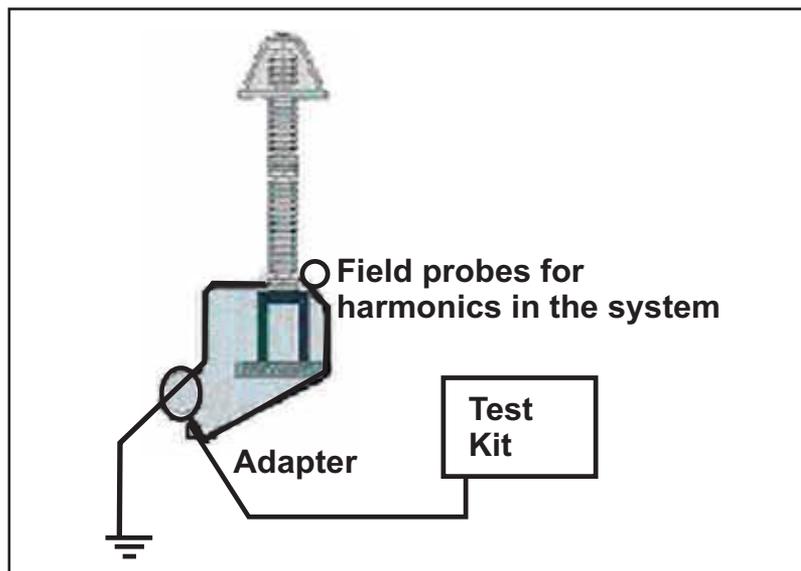


Figure- 18 Typical arrangement for THRCM Test

EVALUATION OF TEST RESULTS

- A. ZnO Surge Arrester continuously conducts a small leakage current (Fig.19). The resistive component of this leakage current may increase with time due to different stresses causing ageing and finally cause arrester failure.
- B. If Harmonics are present in the system voltage, it affects the value of measured third harmonic current. Compensating device provided to be used to nullify the effect. The value of Third Harmonic Resistive current shall be less than $30 \mu\text{A}$

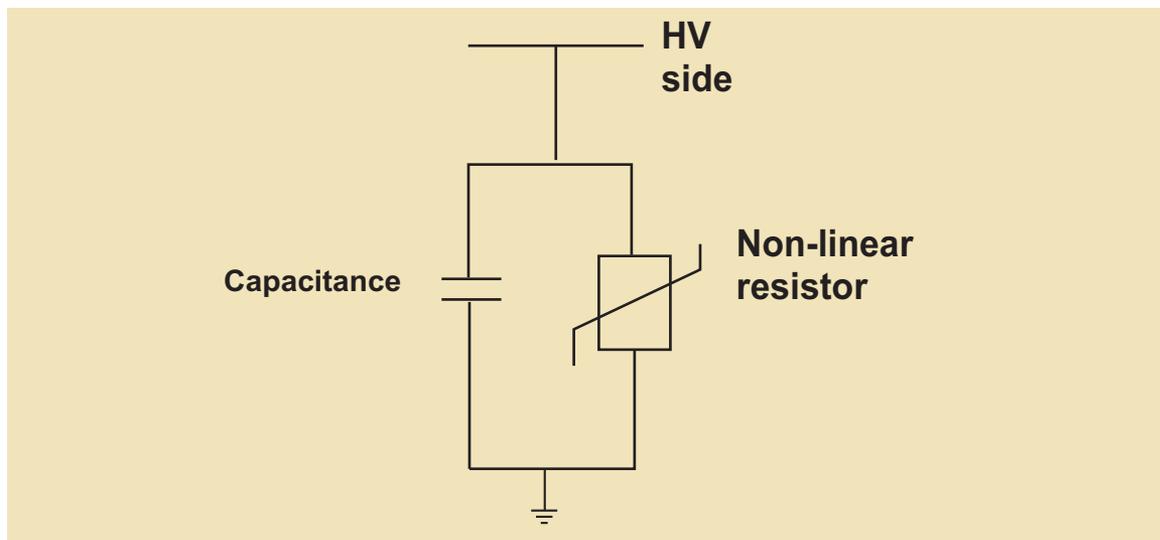


Figure-19 Arrester equivalent circuit

6.7 CHECKS/ TESTS FOR OTHER AREAS/ EQUIPMENTS

6.7.1 EARTH RESISTANCE MEASUREMENT

Normally Earth tester is used for measuring

- (a) Soil resistivity
- (b) Earth resistance

- a. Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred for procedures to be adopted for measurement of soil resistivity and earth resistance.

A typical earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1, P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the scale of the instrument. If R is the resistance measured then

$$\text{Specific Resistivity} = 2\pi a R$$

Where 'a' is the distance between the electrode

And R is the resistance in ohms measured on the earth tester.

- b. In order to measure earth resistance of the electrode of the substation, it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the Insulation tester. This will give the earth resistance. The value as far as possible should be around 1 ohm. To improve the value, water should be spread at the earth pit.

6.7.2 SECONDARY CURRENT INJECTION TEST SETS

The primary test is essential when commissioning and new installation as a test the whole protection system and will detect current transformers connected with incorrect polarity or relays that have been set in the wrong sequence in differential system. Secondary current injection sets are very useful for conducting these tests. The standard secondary current injection test equipment consists of a 1/5 A current injection set, separate wave form filter unit and a digital counter. The equipment is designed in a portable kit for on site testing of protecting devices, circuit breakers, trip coils, motor overloads, and similar apparatus. The filter unit should be used when testing saturating core type relays to ensure that the test current has a substantially sinusoidal waveform. The typical test setup is shown in fig. 20. Details of the testing will be elaborated in the relay testing.

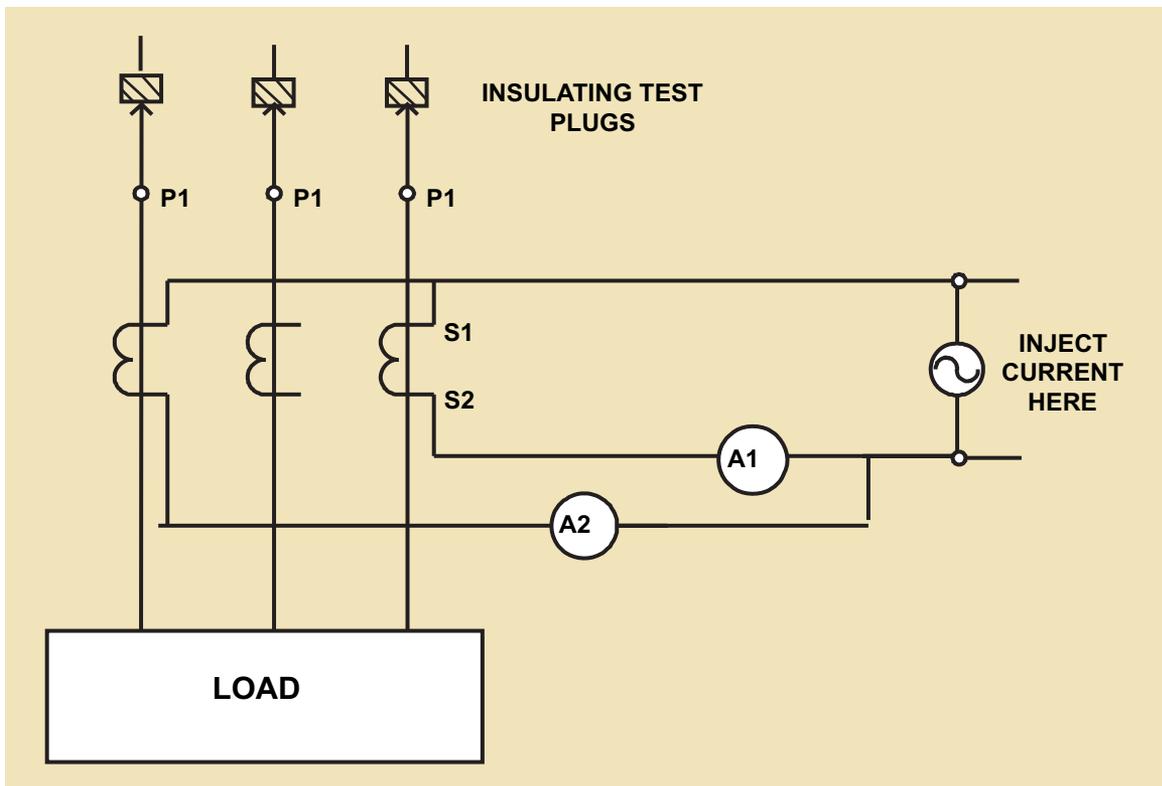


Figure - 20

6.7.3 CONTACT TIGHTNESS TEST OF BAY CONTACTS:

- a. Isolate the Bay from Bus–Side and line side as shown in Fig.-21.
- b. Ensure that all the secondary cores are connected or short if not in use.
- c. Inject the Current at Point 1 (200A) from primary injection kit (w r t earth) and return current via earth point at 2 as shown in Fig.-21.
- d. Check that we are able to inject current at point 1 and measure the current at point 2.
- e. Injection of current is the indication of contact tightness.
- f. Repeat the procedure for point 1 & 3
- g. Repeat the procedure for point 1 & 4

Note: Above tests can be aborted if individual contact resistances are within satisfactory limit and physical phase checking is satisfactory.

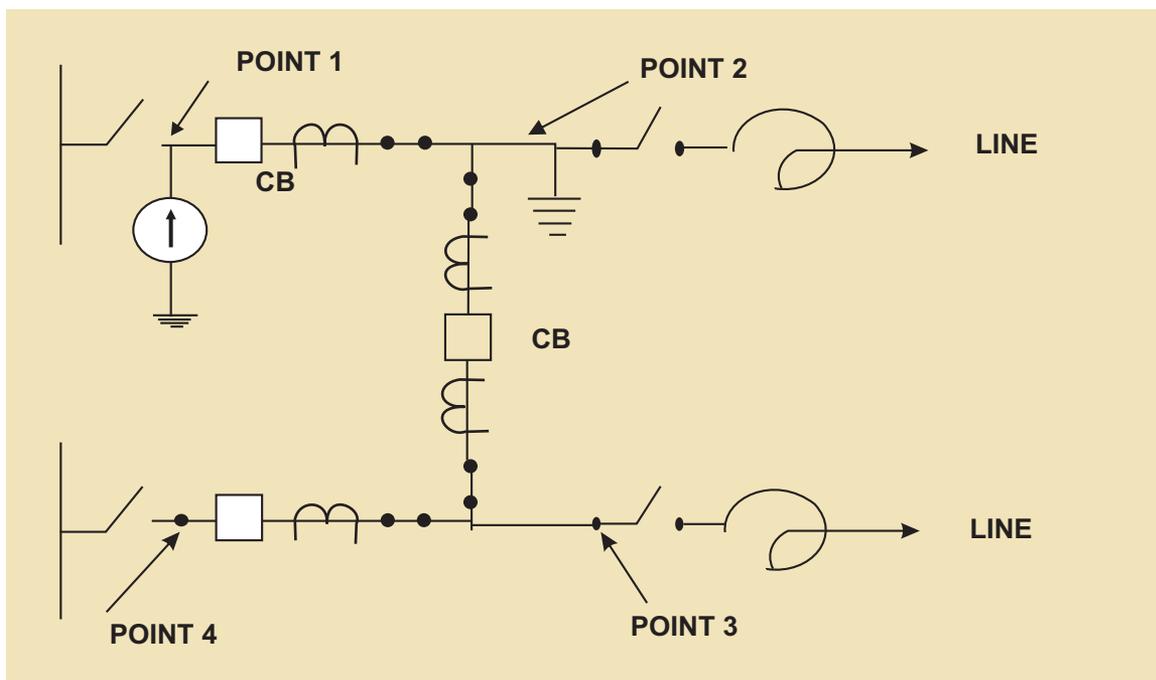


Figure-21 : Primary injection test to check contact tightness of Bay/ feeders

SPECIFIC REQUIREMENT'S (Section- Project)
C/ENGG/SPEC/SEC-PROJECT/SPECIFIC REQUIREMENT REV NO 08

Employer has standardized its Specific Requirement for various equipment and works for different voltage levels. Items or clauses, which are not applicable for the scope of this package as per schedule of quantities described in BPS or as per scope defined elsewhere in Section Project, the technical specification/clauses for the items specified below should not be referred to.

S.No	Clause No.	Amended As (As per Specific Requirement Rev 08)
A. Section: GTR Rev 15		
1.	Section GTR, Rev-15 Clause 2.1 (a)	<p>"All equipment/materials/items, as per Annexure-K (Rev 01), as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only with Minimum Local Content for individual items as listed in the above annexure.</p> <p>Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.</p> <p>The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract."</p>
2.	New Clause no 2.1 C	Equipment/Material/Items from a Indian manufacture who have specified transfer of technology (TOT) arrangement with an entity from a country which shares land border with India shall be accepted only if the Indian Manufacturer is complying the requirement of prevailing Guideline by Government of India under Rule 144(xi) of the General financial Rule (GFR) 2017
3.	New Clause No. 4.7	<p>Planning and Designing in purview of Vulnerability Atlas of India</p> <p>Vulnerability Atlas of India (VAI) is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/UT wise hazard, maps with respect to earthquakes, winds and floods for district wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation stage.</p> <p>This Atlas is one of its kind single point source for the various stakeholders including policy makers, administrators, municipal commissioners, urban managers, engineers, architects, planners, public etc. to ascertain proneness of any city/ location/ site to multi-hazard which includes earthquakes, winds, floods thunderstorms, cyclones and landslides. While project formulation, approvals and implementation of various urban housing, buildings and infrastructures schemes, this Atlas provides necessary information for risk analysis and hazard assessment.</p> <p>The Vulnerability Atlas of India has been prepared by Building Materials and Technology Promotion Council under Ministry of Housing and Urban Affairs, Government of India and available at their website https://www.bmtpc.org/. It is mandatory for the bidders to refer Vulnerability Atlas of India for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning and designing the project in terms of:</p>

		<ul style="list-style-type: none"> i) Seismic zone for earthquakes, ii) Wind velocity iii) Area liable to floods and Probable max. surge height iv) Thunderstorms history v) Number of cyclonic storms/ severe cyclonic storms and max sustained wind specific to coastal Region vi) Landslides incidences with Annual rainfall normal vii) District wise Probable Max. Precipitation 																																																																		
4.	New Para under Clause no. 8.3.2	Wherever references to SFQP is made in Technical Specifications, it shall be the latest edition/revision of the same uploaded up to seven (7) days prior to the actual date of bid opening.																																																																		
5.	Clause no. 9.2	<p>The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.</p> <p>Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within the years specified below from the date of NOA. In case the test reports are of the test conducted earlier than the years specified below from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer:-</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">S. No.</th> <th style="text-align: center;">Name of Equipment</th> <th style="text-align: center;">Validity of type test(in years)</th> </tr> </thead> <tbody> <tr><td>1</td><td>Power Transformer</td><td>5</td></tr> <tr><td>2</td><td>LT Transformer</td><td>5</td></tr> <tr><td>3</td><td>Shunt Reactor</td><td>5</td></tr> <tr><td>4</td><td>OLTC</td><td>10</td></tr> <tr><td>5</td><td>Bushing of Power Transformers/Reactors</td><td>7</td></tr> <tr><td>6</td><td>Fittings and accessories for Power transformers & Reactors</td><td>10</td></tr> <tr><td>7</td><td>Circuit Breaker</td><td>10</td></tr> <tr><td>8</td><td>Isolator</td><td>10</td></tr> <tr><td>9</td><td>Lighting Arrester</td><td>10</td></tr> <tr><td>10</td><td>Wave Trap</td><td>10</td></tr> <tr><td>11</td><td>Instrument transformer</td><td>10</td></tr> <tr><td>12</td><td>GIS & Hybrid GIS</td><td>15</td></tr> <tr><td>13</td><td>LT Switchgear</td><td>10</td></tr> <tr><td>14</td><td>Cable and associated accessories</td><td>10</td></tr> <tr><td>15</td><td>Relays</td><td>7</td></tr> <tr><td>16</td><td>Capacitors</td><td>10</td></tr> <tr><td>17</td><td>Battery and Battery charger</td><td>10</td></tr> <tr><td>18</td><td>Conductor & Earth wire</td><td>10</td></tr> <tr><td>19</td><td>Insulators (Porcelain/Glass)</td><td>10</td></tr> <tr><td>20</td><td>Composite Insulators</td><td>5</td></tr> <tr><td>21</td><td>PLCC</td><td>5</td></tr> </tbody> </table>	S. No.	Name of Equipment	Validity of type test(in years)	1	Power Transformer	5	2	LT Transformer	5	3	Shunt Reactor	5	4	OLTC	10	5	Bushing of Power Transformers/Reactors	7	6	Fittings and accessories for Power transformers & Reactors	10	7	Circuit Breaker	10	8	Isolator	10	9	Lighting Arrester	10	10	Wave Trap	10	11	Instrument transformer	10	12	GIS & Hybrid GIS	15	13	LT Switchgear	10	14	Cable and associated accessories	10	15	Relays	7	16	Capacitors	10	17	Battery and Battery charger	10	18	Conductor & Earth wire	10	19	Insulators (Porcelain/Glass)	10	20	Composite Insulators	5	21	PLCC	5
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		<p>Note:- For all other equipment's validity of type test shall be 10 years from date of NOA.</p> <p>Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.</p> <p>The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.</p>
6.	Section GTR Rev 15 Clause No 24.1	<p>Technical requirements for 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment*:</p> <p>A) Circuit Breaker</p> <p>(i) The manufacturer(s) whose 765/400/220/132kV* Circuit Breaker(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class Circuit Breaker(s), which are in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered Circuit Breaker and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715/345/220/132kV* or higher Voltage class Circuit Breaker(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>b) In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two (2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered Circuit Breaker(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the Circuit Breaker(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.</p> <p>B) Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)</p> <p>(i) The manufacturer whose 765/400/220/132kV* equipment(s) are offered, must have manufactured, type tested (as per IS/IEC or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA.</p>

OR

(ii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) and not meeting the requirement stipulated in (i) above, can also be considered provided that:

- a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA
- b) Manufacturer has manufactured, type tested (as per IS/IEC or equivalent standard) and supplied equipment(s) of 345kV or above voltage class (applicable for 765kV* Equipment)/220kV or above voltage class (applicable for 400kV* equipment) /132kV or above voltage class (applicable for 220kV* equipment) / 66kV or higher voltage class (applicable for 132kV* equipment), which are in satisfactory operation# for at least two (2) years as on the date of NOA.
- c) Warranty obligations for additional warranty of two (2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipment(s)* for the additional warranty period in addition to the contract Performance guarantee to be submitted by the contractor.

OR

(iii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) based on technological support of a parent company or collaborator and not meeting the requirement stipulated in (i) above, can also be considered provided that:

- a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA.
- b) The parent company or collaborator meets the qualifying requirements stipulated under (i) given above.

A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply the 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment(s)* in India, shall be submitted.

- c) The parent company/collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in

		<p>addition to contract performance guarantee to be submitted by the contractor</p> <p>Legends: * : voltage class of respective equipment as applicable. # : satisfactory operation means certificate issued by the Employer/Utility certifying the operation without any adverse remark.</p> <p>NOA: Notification of Award</p>
7.	Clause No 24.2	<p>Technical Requirement for 765kV class Transformer</p> <p>(i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA, and the same transformer (s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor</p>
8.	Clause No 24.3	<p>Technical Requirement for 765kV class Reactor</p> <p>(i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Reactor of at least 110 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 36.7 MVAR and the same Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>The Manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA and the bidder should have designed, manufactured, tested & supplied 345 kV or higher voltage class one (1) number 3-phase Reactor of at least 50 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 16.7 MVAR and the same Transformer(s) & Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p>

		<p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715 kV or higher voltage class either One (1) no. 1-phase Reactor of at least 80 MVAR capacity or One (1) no. 1-phase Transformer of at least 166 MVA capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor</p>						
<p>9.</p>	<p>Clause No 24.4</p>	<p>Technical Requirement for 400kV, 220kV, 132kV class Transformer</p> <p>(i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:</p> <table border="1"> <tr> <td>345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA</td> <td>applicable for supply of 400kV class Transformer</td> </tr> <tr> <td>220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA</td> <td>applicable for supply of 220kV class Transformer</td> </tr> <tr> <td>commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA</td> <td>applicable for supply of 132kV class Transformer</td> </tr> </table> <p>These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 220kV (applicable for supply of 400kV class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kVclass Transformer)or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p>	345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA	applicable for supply of 400kV class Transformer	220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA	applicable for supply of 220kV class Transformer	commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA	applicable for supply of 132kV class Transformer
345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA	applicable for supply of 400kV class Transformer							
220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA	applicable for supply of 220kV class Transformer							
commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA	applicable for supply of 132kV class Transformer							

		<p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV/220kV/132kV* transformer in India, shall be submitted.</p> <p>c) The collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>
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10.	Clause No 24.5	<p>Technical Requirement for 400kV, 220kV and 132kV class Reactor</p> <p>(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested & supplied Reactor as per table below:</p> <table border="1" style="margin-left: 40px;"> <tr> <td style="padding: 5px;">345kV or above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors, each having capacity of at least 16.7 MVAR</td> <td style="padding: 5px;">applicable for supply of 400kV class Reactors</td> </tr> <tr> <td style="padding: 5px;">220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR</td> <td style="padding: 5px;">applicable for supply of 220kV class Reactors</td> </tr> <tr> <td style="padding: 5px;">132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR</td> <td style="padding: 5px;">applicable for supply of 132kV class Reactors</td> </tr> </table> <p style="margin-left: 40px;">These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor</p>	345kV or above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors, each having capacity of at least 16.7 MVAR	applicable for supply of 400kV class Reactors	220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR	applicable for supply of 220kV class Reactors	132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR	applicable for supply of 132kV class Reactors
345kV or above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors, each having capacity of at least 16.7 MVAR	applicable for supply of 400kV class Reactors							
220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR	applicable for supply of 220kV class Reactors							
132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR	applicable for supply of 132kV class Reactors							

11.	Clause No 24.6	<p>Technical Requirement for 400 kV Grade XLPE Power Cables</p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.</p> <p>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor</p>
12.	Clause No 24.7	<p>Technical Requirement for 220KV,132kV,110kV Grade XLPE Power Cables</p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/132kV/110kV* or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/132kV/110kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/132kV/110kV* or higher grade XLPE insulated Cable as on the date of NOA.</p> <p>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee</p>

		shall be in addition to the contract performance guarantee to be submitted by the contractor
13.	Clause No 24.15	<p>Technical Requirements for LT Transformer</p> <ul style="list-style-type: none"> (i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 315kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that At least 33kV class of 315kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA. <p>Note In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.</p>
14.	Clause no 24.16	<p>Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)</p> <ul style="list-style-type: none"> (i) The manufacturer whose Composite Long rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for at least two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that <ul style="list-style-type: none"> a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA. b) Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor. <p>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.</p>

<p>15.</p>	<p>Clause No. 24.20</p>	<p><u>Technical Requirement for 400kV GIS Equipment</u></p> <p>(i) The manufacturer whose 400kV GIS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) Atleast one no. 345kV or above voltage class GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above CB bay (as per IEC or equivalent standard) as on the date of NOA.</p> <p>b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV or above voltage level GIS equipment in India, shall be submitted.</p> <p>c) The Collaborator(s) shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.</p> <p>Note :- (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable.</p>
<p>16.</p>	<p>New Clause Clause No. 24.21</p>	<p><u>Technical Requirement for 220/132/66 kV* level GIS/Hybrid GIS/MTS Equipment:</u></p> <p>(i) The manufacturer whose 220/132/66 kV* level GIS/Hybrid GIS/MTS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 220/110/66kV* or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) Atleast one no. 220/110/66kV* or above voltage level GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above GIS bay (as per IEC or equivalent standard) as on the date of NOA.</p>

b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 220/110/66*kV or above voltage level GIS equipment in India shall be submitted.

c) The Collaborator(s) shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.

Note:

- (*) voltage class of respective equipment as applicable
- (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnecter and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear.
- Experience with combination of GIS CB Bay/Hybrid GIS CB Bay/MTS CB Bay is also acceptable if supply of only Hybrid/MTS equipment is envisaged. Hybrid GIS means outdoor SF6 Gas insulated switchgear connected to outdoor Air insulated bus-bar System (AIS bus-bars System), MTS means outdoor SF6 Gas insulated Mixed Technology Switchgear connected to outdoor AIS bus bar system.
- (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable

17. **New Clause 27.0**

The technical parameters for 36kV & 12kV Horn gap fuse

1. 36kV Horn Gap Fuse

1.	Rated voltage	33 kV
2.	Maximum Continuous voltage	36 kV
3.	Rated current	50 Amps (min)
4.	Rated short time withstand (in KA)	25KA for 1 sec.
5.	Lighting Impulse voltage withstand	170 KV (Between Live and earth) 195 KV (Across open terminals)
6.	One minute Power frequency voltage withstand (Dry and Wet)	70 KV (Between Live and earth) 80 KV (Across open terminals)
7.	Creepage	900mm

2. 12kV Horn Gap Fuse

1.	Rated voltage	11 kV
2.	Maximum Continuous voltage	12 kV
3.	Rated current	50 Amps (min)
4.	Rated short time withstand (in KA)	12KA for 1 sec.
5.	Lighting Impulse voltage withstand	75 KV (Between Live and earth) 85 KV (Across open terminals)

		6.	One minute Power frequency voltage withstand (Dry and Wet)	28 KV (Between Live and earth) 32 KV (Across open terminals)
Applicable standard: IS9385				
B. Section GIS Rev 5A				
1.	New Para under Clause no.1	GIS of all voltage levels above 52kV class envisaged in one substation under a single package, shall be supplied from one GIS manufacturer who shall be responsible for design, manufacturing, erection, testing and commissioning of complete GIS switchyard under the Contract and any other responsibilities stipulated in the contract with respect to GIS portion. GIS shall be accepted from manufacturer for which JDU is submitted along with the bidding documents.		
2.	Clause no. 5.31	Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits. Gas Insulating System: i) Loss of Gas Density Operating System: i) Low operating pressure ii) Loss of operating power iii) Loss of control supply iv) Pole Discordance.		
3.	New Clause no. 5.39.8	Reference Guidelines for GIS Grounding shall be as per Annexure-12 (Attached at Annexure-S10)		
4.	Clause no. 5.40	Adequate number of UHF sensors shall be provided in the offered GIS of voltage level 220kV and above for detection of Partial discharge (of 5pC and above) as per IEC 60270. The number and location of these sensors.....in close proximity to VT compartments. However, adequacy of number of sensors..... to complete the technical requirement. The calibration and frequency response.....couplers meeting this requirement.		
5.	New Clause no. 5.41(10)	The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule.		
6.	New Para added under Clause no. 5.43.2	The gas density monitoring devices shall have IP rating of IP65 or better and Suitable canopy shall be provided to prevent ingress of rain water for outdoor application.		
7.	New Clause no. 5.43.3	Requirement for Gas Zone Trip Scheme of GIS gas Tight Compartments: a) Gas Zone tripping scheme is envisaged to isolate the GIS compartment when its gas level falls below gas zone trip level (i.e. minimum functional pressure) b) Density monitor Contact for gas zone tripping shall close when SF6 gas level falls below gas zone trip level in the respective compartment. c) Gas zone tripping shall be interlocked with the associated GIS disconnecter so that tripping doesn't take place when a gas tight compartment is in electrically isolated condition from rest of the GIS (Disconnecter open). Further, Gas zone tripping scheme should not mal-operate during control DC failure/changeover. Gas zone tripping scheme shall be coordinated with CRP scheme and shall be submitted for employer's approval during detailed engineering.		

8.	Clause no. 6.8.2	<p>The CSD shall be provided in following circuit breakers:</p> <ul style="list-style-type: none"> a) 765kV <ul style="list-style-type: none"> • Main and Tie bay for Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay b) 400kV <ul style="list-style-type: none"> • Main and Tie bay for 765/400kV Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay c) 220 & 132kV <ul style="list-style-type: none"> • Bay for operation of Shunt reactor <p>The requirement of CSD shall be explicitly specified in price schedule.</p>																		
9.	New Clause 6.8.3 (n)	<p>For Circuit breaker with CSD controlling a Transformer following is applicable</p> <p>“The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations”.</p>																		
10.	New Clause no. 10.1.3(n)	<p>For 400kV & above voltage class GIS bay module, CT cores shall be duly distributed on both side of circuit breaker. For 220 kV and below voltage level GIS bay module, CT on one side of the circuit breaker is also acceptable.</p>																		
11.	New Clause no. 15.2.14	<p>All 765kV & 400kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD by using a suitable selector switch irrespective of whether circuit breakers to be supplied are envisaged along with CSD or not as per bid price schedules.</p>																		
12.	Clause no. 17.1	<p>One EOT Crane of suitable capacity shall be provided for erection & maintenance of largest/heaviest GIS component/assembly for each GIS hall. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.</p>																		
13.	New Para added under Clause no. 20	<p>During detailed engineering, the type test reports of GIS equipment of the parent company/subsidiary company/group company shall also be acceptable provided that the design of offered GIS is same as that of type tested GIS equipment.</p>																		
14.	Clause no 20, Sl. no. 14 of Table	14	<p>Reactor current switching test for Inductive Current switching capability as per IEC 62271-110. Further, the manufacturer whose circuit breakers tested with smaller current w.r.t current limits specified for Reactor current switching test duty-2, 3 & 4 in IEC 62271-110 shall also be acceptable.</p>																	
15.	Annexure-1 S.No. 20 (i)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Parameter</th> <th style="width: 20%;">765kV system</th> <th style="width: 20%;">400kV system</th> <th style="width: 15%;">220kV system</th> <th style="width: 15%;">132 kV system</th> </tr> </thead> <tbody> <tr> <td>Pre-insertion resistor requirement</td> <td>As per BPS</td> <td>As per BPS</td> <td>NA</td> <td>NA</td> </tr> <tr> <td>Rating (ohms)</td> <td>Approx. 450 with tolerance as applicable</td> <td>Approx. 400 with tolerance as applicable</td> <td>NA</td> <td>NA</td> </tr> </tbody> </table>				Parameter	765kV system	400kV system	220kV system	132 kV system	Pre-insertion resistor requirement	As per BPS	As per BPS	NA	NA	Rating (ohms)	Approx. 450 with tolerance as applicable	Approx. 400 with tolerance as applicable	NA	NA
Parameter	765kV system	400kV system	220kV system	132 kV system																
Pre-insertion resistor requirement	As per BPS	As per BPS	NA	NA																
Rating (ohms)	Approx. 450 with tolerance as applicable	Approx. 400 with tolerance as applicable	NA	NA																

16.	New Para under Clause no 26.	Requirement for Mandatory spares for GIS a. Any equipment which is not supplied as main equipment or part of main equipment, mandatory spare for that is not applicable. b. It is recognized that the GIS manufacturer may have standardized the GIS design/equipment rating based on the manufacturer's standard practice. Alternate proposals, offering higher rating equipment (without additional cost implication), will also be considered provided such equipment meets the specified minimum designs rating, standard and performance requirements. c. In case contractor offers circuit breaker, dis-connector, current transformer, SF6/Air Bushing etc. under main equipment of higher rating than equipment rating specified in the specifications, the mandatory spare of same higher rating offered by contractor identical to main equipment offered in the package shall be required to be supplied against spares without any cost implication to POWERGRID.
17.	Annexure-10 Rev-1	Annexure-10 Rev-1 (Standard Mandatory Spares for Gas Insulated Switchgear) of stands deleted.
18.	New Annexure-13	Standard GIS Module Description (Attached at Annexure-S11)
C. Section Switchgear – CB Rev 11		
1.	Clause no. 2.6 Para 2	The CSD shall be provided in following circuit breakers: d) 765kV <ul style="list-style-type: none"> • Main and Tie bay for Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay e) 400kV <ul style="list-style-type: none"> • Main and Tie bay for 765/400kV Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay f) 220 & 132kV <ul style="list-style-type: none"> • Bay for operation of Shunt reactor The requirement of CSD shall be explicitly specified in price schedule.
2.	New Clause no. 2.6.1(n)	For Circuit breaker with CSD controlling a Transformer following is applicable “The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations”.
3.	Clause No. 11.4	Separate cables shall be used for AC, DC-I, DC-II and selected DC. Each control cable shall include minimum 10% spare cores (subject to minimum 1 no. of spare core).
4.	Clause No. 11.5	Requirement of Plug-In type connector for Inter-pole cabling is deleted
5.	Clause No. 11.6	Vertical run of cables to the operating mechanism box shall be properly supported by providing the perforated closed type galvanized cable tray (Cable tray also to be supplied along with the Circuit Breaker) to be fixed as an integral part of the structures. The load of the cable shall not be transferred to the mechanism box/terminal arrangement in any circumstances. Hanging or loose run of cable is not permitted. The drawing of cable tray including fixing arrangement shall be incorporated in the GA drawing of CB also.

6.	Clause No. 16.0 S.No. 20 (i)	Parameter	765kV system	400kV system	220kV system	132 kV system	66kV System
		Pre-insertion resistor requirement	As per BPS	As per BPS	NA	NA	NA
		Rating (ohms)	Approx. 450 with tolerance as applicable	Approx. 400 with tolerance as applicable	NA	NA	NA
D. Section Switchgear-INST Rev 11							
1.	Clause No. 6.2 (a)(iii)	Seismic withstand test as per Annexure-B of Section-GTR or IEC62271-2 (with Seismic acceleration requirement as per Annexure-I of this specification/Section-Project) for 400kV and above voltage rating.					
2.	Clause No. 6.2 (b)(iii) & (c)(iii)	Seismic withstand test (as per Annexure-B of Section-GTR) or IEC-62271-2 (with Seismic acceleration requirement as per Annexure-II of this specification/Section-Project) for 400kV and above voltage class.					
3.	Clause No. 9.2 Para 3 & 4	<p>CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.</p> <p>Manufacturer/Contractor shall supply 2 nos. of oil sampling device for every 20 nos. of oil filled CT supplied with a minimum of 2 nos. of oil sampling device for each substation. The price of the above sampling bottles is deemed to be included in cost of equipment.</p>					
4.	Clause No. 9.3	<p>Voltage Transformers</p> <ol style="list-style-type: none"> Insulation Resistance test for primary (if applicable) and secondary winding Polarity test Ratio test Dielectric test of oil (wherever applicable) Tan delta and capacitance measurement of individual capacitor stacks Secondary winding resistance measurement DGA of oil (for IVT/PT) <p>Dissolved Gas Analysis (DGA) shall be carried out twice within the first year of service, first within the first month of commissioning/charging and second between six months to one year from the date of commissioning/charging.</p> <p>IVTs/PTs must have adequate provision for taking oil samples from the bottom of the IVT/PT without exposure to atmosphere. Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Manufacturer should also indicate the total quantity of oil which can be withdrawn from IVT/PT for gas analysis before refilling or further treatment of IVT becomes necessary. Manufacturer/Contractor shall supply 2 nos. of oil sampling device for every 20 nos. of oil filled IVT/PT supplied with a minimum of 2 nos. of oil sampling device for each substation. The price of the above sampling bottles is deemed to be included in cost of equipment.</p>					
5.		Defect Liability					

	Clause No. 10.0	The actions required to be taken by contractor in case of defects observed in CT/CVT/IVT/PT of ratings 145kV & above during the warranty period (defect liability period) shall be as per enclosed Annexure-V (Revised) of this specification. Further, the replaced/repaired/refurbished equipment (or part of equipment) shall have Two (2) years warranty without prejudice to contractual warranty period (defect liability period).																																																														
6.	New Table - II.C.1	<p style="text-align: center;">REQUIREMENTS FOR 245 KV 2500A, 120% CURRENT TRANSFORMER</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%;">Nos of core</th> <th style="width: 5%;">Core no.</th> <th style="width: 10%;">Application</th> <th style="width: 10%;">Current ratio</th> <th style="width: 5%;">Output Burden</th> <th style="width: 5%;">Accuracy Class</th> <th style="width: 5%;">Min. knee pt. voltage (Vk)</th> <th style="width: 5%;">Max CT Sec. Wdg-resistance (ohms)</th> <th style="width: 10%;">Max Excitation Current at Vk (in mA)</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>1</td> <td>BUS DIF F CHECK</td> <td>2500-1600-800/1</td> <td>-</td> <td>PX</td> <td>2500-1600-800 V</td> <td>12.5/8/4</td> <td>16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap</td> </tr> <tr> <td></td> <td>2</td> <td>BUS DIF F CHECK</td> <td>2500-1600-800/1</td> <td>-</td> <td>PX</td> <td>2500-1600-800 V</td> <td>12.5/8/4</td> <td>16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap</td> </tr> <tr> <td></td> <td>3</td> <td>METERING</td> <td>2500-1600-800/1</td> <td>20V A</td> <td>0.2S</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td></td> <td>4</td> <td>TRANS BAC KUP /LINE PROTN</td> <td>2500-1600-800/1</td> <td>-</td> <td>PX</td> <td>2500-1600-800 V</td> <td>12.5/8/4</td> <td>16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap</td> </tr> <tr> <td></td> <td>5</td> <td>TRANS DIF/LINE PROTN</td> <td>2500-1600-800/1</td> <td>-</td> <td>PX</td> <td>2500-1600-800 V</td> <td>12.5/8/4</td> <td>16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap</td> </tr> </tbody> </table> <p>Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869. 2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869</p>									Nos of core	Core no.	Application	Current ratio	Output Burden	Accuracy Class	Min. knee pt. voltage (Vk)	Max CT Sec. Wdg-resistance (ohms)	Max Excitation Current at Vk (in mA)	5	1	BUS DIF F CHECK	2500-1600-800/1	-	PX	2500-1600-800 V	12.5/8/4	16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap		2	BUS DIF F CHECK	2500-1600-800/1	-	PX	2500-1600-800 V	12.5/8/4	16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap		3	METERING	2500-1600-800/1	20V A	0.2S	-	-	-		4	TRANS BAC KUP /LINE PROTN	2500-1600-800/1	-	PX	2500-1600-800 V	12.5/8/4	16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap		5	TRANS DIF/LINE PROTN	2500-1600-800/1	-	PX	2500-1600-800 V	12.5/8/4	16 on 2500/1 tap; 25 1600/1 Tap; 50 on 800/1 Tap
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7.	New Table -II G	<p style="text-align: center;">REQUIREMENT FOR 36kV NCT 3000A (120% extended) (Outdoor type) for bank of 765kV, 1-Ph Transformer Location: Common Neutral Side (for each three-phase bank)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%;">Nos of core</th> <th style="width: 5%;">Core no.</th> <th style="width: 10%;">Application</th> <th style="width: 10%;">Current ratio</th> <th style="width: 5%;">Output Burden</th> <th style="width: 5%;">Accuracy Class</th> <th style="width: 5%;">Min. knee pt. voltage (Vk)</th> <th style="width: 5%;">Max CT Sec. Wdg-resistance (ohms)</th> <th style="width: 10%;">Max Excitation Current at Vk (in mA)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>REF (Hig</td> <td>3000/1</td> <td>-</td> <td>PX</td> <td>3000 V</td> <td>12</td> <td>20 on 3000/1tap</td> </tr> </tbody> </table>									Nos of core	Core no.	Application	Current ratio	Output Burden	Accuracy Class	Min. knee pt. voltage (Vk)	Max CT Sec. Wdg-resistance (ohms)	Max Excitation Current at Vk (in mA)	1	1	REF (Hig	3000/1	-	PX	3000 V	12	20 on 3000/1tap																																				
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8.	New Table -II H	REQUIREMENT FOR 36kV NCT 300A (200% extended) (Outdoor type) for bank of 765kV, 1-Ph Reactor Location: Common Neutral Side (for each three-phase bank)								
		Nos of core	Core no.	Application	Current ratio	Output Burden	Accuracy Class	Min. knee pt. voltage (Vk)	Max CT Sec. Wdg-resistance (ohms)	Max Excitation Current at Vk/4 (in mA)
		1	1	Earth fault protection	300/1	-	PX	300 V	1	40 on 300/1tap
		Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.								
E.	Section Switchgear-ISOLATOR Rev 12									
1.	New Clause No. 2.0. f)	The values of transfer current and recovery voltage of 220kV class bus isolators shall be specified by manufacturer & Bus Isolators shall be type tested for bus transfer current switching duty as per latest IEC62271-102. Test reports is to be submitted for the Employer's review."								
F.	Section Switchgear-Surge Arrester Rev 12									
1.	New Clause No. 4.5	The Surge Arresters shall be provided with a common Junction box suitably for a set of three (3) Surge Arresters of each bay for extending the contact information of surge counter to SAS								
G.	Section: Lighting System Rev 07									
1.	New Para under Clause No. 2.1	Wherever, Indoor Illumination of building is specified as LS/Lot/SET item in BPS, illumination shall be provided using fixture types as specified in Annexure-I of Section: Lighting System. However, contractor shall submit lighting design calculation for deciding the number of fixtures in each building/room. Following Average lux (at working plane of height 1.2Mtrs from floor level) levels to be maintained for design of illumination system:								
		Sl. No.	Building/Room Type						Average Lux Level to be maintained	
		1	Control Room /Station-In charge Room /Administrative Room/Conference Room / Switchyard Panel Room/ GIS Relay Panel Room						300 Lux	
		2	Electronic Test Lab						250 Lux	
		3	GIS Hall/ Battery Room/ACDC & DCDB Room						200 Lux	

		<table border="1"> <tr> <td>4</td> <td>AHU Room/GIS Store Room/ Pantry /Reception/ FFPH Building</td> <td>150 Lux</td> </tr> <tr> <td>5</td> <td>Corridor/ Toilets</td> <td>100 Lux</td> </tr> <tr> <td>6</td> <td>Periphery of the Building</td> <td>50 Lux</td> </tr> <tr> <td>7</td> <td>Any other room/building</td> <td>200 Lux</td> </tr> </table> <p>The minimum lux level to average lux level ratio should not be less than 0.6 (i.e $E_{min}/E_{av} > 0.6$). The maintenance factor for indoor illumination design shall be considered as 0.8.</p> <p>All required items /equipment /fixtures/ panels/ receptacles/ switches/ switchboards/ fans etc. for Illumination of Control Room Building, GIS Building, FFPH, SPR, Security Hut etc. (as applicable) are deemed to be included under corresponding LS/Lot/SET item of BPS.</p>	4	AHU Room/GIS Store Room/ Pantry /Reception/ FFPH Building	150 Lux	5	Corridor/ Toilets	100 Lux	6	Periphery of the Building	50 Lux	7	Any other room/building	200 Lux
4	AHU Room/GIS Store Room/ Pantry /Reception/ FFPH Building	150 Lux												
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2.	Clause no. 6.2.1(ii)	<p>All Outdoor Lighting Panels shall be Stainless sheet steel of Grade 304 and shall be dust, weather and vermin proof. Panels shall be of thickness not less than 1.5 mm smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.</p> <p>Alternatively, outdoor lighting panels of Aluminum shall also be acceptable as per provisions stipulated in Section GTR.</p>												
3.	Clause no. 6.6(i) (b)	<p>The outdoor junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of Cable glands of required size. The junction boxes shall be provided with 4 way knockouts suitable for street lighting/switchyard lighting terminals suitable for 2 numbers 4C x 16 Sq.mm Al. cable or as per requirement. All Outdoor Junction boxes shall be of Stainless Steel of thickness 1.5mm of grade 304. Outdoor Junction Boxes shall be suitable for mounting on columns, structures etc. for Outdoor Lighting. The outdoor Junction shall have IP 55 protection. Alternatively, outdoor junction boxes of Aluminum shall also be acceptable as per provisions stipulated in Section GTR.</p>												
4.	New para under Clause no 5.1	<p>EXTERNAL ELECTRIFICATION WORKS</p> <p>Para-1</p> <hr/> <p>Para-2</p> <hr/> <p>Para-3</p> <p>Townships DB's shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Gland plate shall be cold rolled sheet steel having thickness not less than 3 mm in all cases. However, in case of termination of single core power cables, gland plate shall be of non-magnetic material of at least 4mm thickness.</p> <p>Township DB shall be provided with a degree of protection of IP: 55.</p>												
H.	Section: LT Switchgear Rev 05													
1.	Clause no. 1.21.2	Contractor shall submit type test reports for the Lighting transformers as per IS:2026 for which test conducted once are acceptable (i.e. The requirement of test conducted within last ten years shall not be applicable)												
2.	Clause no. 1.6.1	MCCB shall in general conform to IS: 13947 Part-2. All MCCB offered shall have Ics = 100% Icu rating.												
I.	Section DG Set Rev 05													

1.	New para added under Clause no. 7.1(a)	Alternatively, AMF Panel for DG Set may be installed outside the acoustic enclosure near the DG Set. In such cases, AMF panel with or without additional enclosure shall meet IP-55 degree of protection.																								
J. Section: Battery and Battery Charger Rev 06																										
1.	Clause no. 1.2.12	The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity.																								
2.	Clause no 1.1.4 table -2 (48V)	Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:- <table border="1"> <thead> <tr> <th>220V DC system</th> <th>Load</th> <th>Duration</th> <th>Type Of Loads</th> </tr> </thead> <tbody> <tr> <td>.....</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>.....</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>.....</td> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>48V DC System</td> <td>Continuous Load</td> <td>10 hours Continuous</td> <td>load associated with PLCs.(when speech is not working)</td> </tr> <tr> <td></td> <td>Momentary Load</td> <td>15 minute</td> <td>Loads associated with PLCs (when speech is working)</td> </tr> </tbody> </table>	220V DC system	Load	Duration	Type Of Loads	48V DC System	Continuous Load	10 hours Continuous	load associated with PLCs.(when speech is not working)		Momentary Load	15 minute	Loads associated with PLCs (when speech is working)
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K. Section Fire Protection Rev 06																										
1.	New para added at Clause no.2.03.00	Fire detection and alarm system shall also be provided in the GIS Hall using beam type smoke detectors to be installed at suitable mounting height, and in the Relay Panel room with ionization/optical type smoke detectors to be installed on the ceiling.																								
2.	New Clause no.2.01.02	Hydrant posts and Fire extinguishers (CO2 and DCP type) shall also be provided for GIS Building also.																								
3.	Clause No. 2.04.02 & 10.00.00	Mechanical foam type fire extinguishers wherever specified as 50 litre capacity, conforming to IS:13386, shall be read as 60 litre capacity conforming to IS 16018 Further in case of non-availability of any type of fire extinguisher (i.e. water, CO2, DPC, foam type) of a particular size as specified in BPS or technical specification, next available higher size conforming to IS shall be supplied.																								
4.	New Clause No. 2.06.05	For new substation, Fire Fighting LT Boards (AC & DC) and Annunciation panels (for FFPH & Control Room Building), shall have number of feeders, annunciation windows, zone-alarm modules (as applicable) required for entire present & specified future scope of the substation.																								
5.	Clause No.9.01.00(c) & Appendix-V	Deleted																								
6.	Appendix-I	Appendix-I (Rev 4) stand replaced by following Appendix-I (Rev 5)																								
7.	Appendix-IV	Revised Appendix-IV Page1 of 13 is replaced by Annexure-IV rev 01 Page1 of 13.																								
L. Section: Power & Control Cable Rev 06																										
1.	Clause no 1.1.4	Refer Annexure-S1 for METHODOLOGY FOR SUPPLY, INSTALLATION & SIZING OF CABLES																								
2.	Clause no 1.2.2	1.2.2. XLPE Power Cables 1.2.2.1. The XLPE (90°C) insulated cables shall be of FRLSH type, C2 category conforming to IS: 7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium																								

		circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. All cables shall be of armoured type. For single core cables, the armouring shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables
3.	Clause no 1.2.3	<p>1.2.3. PVC Power Cables</p> <p>1.2.3.1. The PVC (70°C) insulated power cables shall be of FRLSH type, C2 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. All cables shall be of armoured type. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.</p>
4.	Clause no 1.2.4	<p>1.2.4. PVC Control Cables</p> <p>1.2.4.1. The PVC (70°C) insulated control cables shall be of FRLSH type C2 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables. All cables shall be of armoured type. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.</p>
5.	Clause No. 4.2	Standard lengths for each size of power and control cables shall be 500/1000 meters. However, to avoid cable wastage and cable jointing at site, non-standard lengths of each size of Power & Control cable may also be acceptable subject to maximum length of 1000meters (+ 5% tolerance)
6.	Clause No. 5	<p>5 TYPE TESTS</p> <p>5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.</p> <p>5.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-</p> <p>5.2.1 Following type tests (on one size in a contract) as per IS: 7098 (Part 1) – 1988 including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:</p> <p>a) Physical tests for insulation</p> <p>i) Hot set test</p> <p>ii) Shrinkage test</p> <p>b) Physical tests for outer sheath</p> <p>i) Shrinkage test</p> <p>ii) Hot deformation</p> <p>iii) Heat shock test</p> <p>iv) Thermal stability</p> <p>c) Test for Smoke density (as per relevant IS/IEC standard)</p> <p>d) Test for halogen acid gas evolution.</p> <p>e) Flame Retardant on Single cable.</p> <p>f) Flame Retardant on bunched cable.</p> <p>5.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following tests</p>

		<ul style="list-style-type: none"> a) Water absorption (gravimetric) test. b) Ageing in air oven c) Loss of mass in air oven d) Short time current test on power cables of sizes 240 sqmm and above on <ul style="list-style-type: none"> i) Conductors. ii) Armours. e) Test for armouring wires/strips. f) Oxygen and Temperature Index test. g) Flammability test. h) Smoke density test (on sheathing material) (as per relevant IS/IEC standard)
7.		<p>5.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-</p> <p>5.3.1 Following type tests (on one size in a contract) as per IS: 1554 (Part 1) -1988 including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:</p> <ul style="list-style-type: none"> a) Physical tests for insulation and outer sheath <ul style="list-style-type: none"> i) Shrinkage test ii) Hot deformation iii) Heat shock test iv) Thermal stability b) High voltage test (water immersion test only a.c. test as per clause no. 16.3.1). c) Test for Smoke density (as per relevant IS/IEC standard) d) Test for halogen acid gas evolution. e) Flame Retardant on Single cable <p>5.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following</p> <ul style="list-style-type: none"> a) High voltage test (water immersion d.c. test as per clause no. 16.3.2 of IS: 1554 (Part 1) - 1988). b) Ageing in air oven. c) Loss of mass in air oven. d) Short time current test on power cables of sizes 240 sqmm and above on <ul style="list-style-type: none"> i) Conductors. ii) Armours. e) Test for armouring wires/strips. f) Oxygen and Temperature Index test. g) Flammability test h) Flame Retardant on bunched cable i) Test for Specific optical density of smoke (as per relevant IS/IEC standard)
8.		Note:- In technical data sheet for 1.1kV XLPE/PVC Power cable & PVC control cable, wherever Type & Category of Cable is written FR & C1 shall be read as FR-LSH & C2, other details kept the same.
M.	Section-Air Conditioning Rev-04	
1.	Clause No. 2.3.2.3	Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have minimum energy efficiency rating of 4 star as on the date of NOA.
2.	Clause No. 2.3.3.4	Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have minimum energy efficiency rating of 4 star as on the date of NOA.
3.	Clause no. 2.4	Clause no. 2.4 of Section-Air Conditioning Rev-04 of Technical Specification Void

4.	New Annexure-S2	Annexure S2 – Air Conditioning & Ventilation System for GIS Building													
N. Section Switchyard Erection Rev 10															
1.	New Clause No. 2.5	Transmission line side insulator string along with hardware for line termination shall be in the scope of substation contractor. The erection of same shall be done by associated TL contractor.													
2.	Clause No. 9.4(j) & (k)	S.No	Item	Size	Material										
		j)	Isolator MOM Box	50X6 mm GS flat & Flexible copper braid	Galvanised steel and copper braid										
		k)	Insulator Guy Arrangemen	75x12mm G.S. flat	Galvanised Steel										
3.	New Clause No. 9.5.8	<p>For estimation of riser of new substation/switchyard, maximum spacing of Main Earthmat shall be considered as 30 M x 30 M, 24 M x 24 M, 16 M x 16 M & 12 M x 12 M for 765kV, 400kV, 220kV & 132kV switchyard respectively.</p> <p>Actual spacing for main earthmat shall be finalized during detailed engineering based on soil resistivity data and payment shall be made as per actual executed quantity at site. However, no cost compensation shall be considered in case of actual spacing of main earthmat finalized during detailed engineering is less than that mentioned above.</p> <p>For switchyard extensions, main earthmat spacing shall be considered same as that in the existing switchyard.</p>													
4.	Clause no 9.10.3	<p>Auxiliary earthing mat comprising of minimum 32mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable.</p>													
5.	New Clause No. 10.2	<p>Following type of conductor for Flexible or Rigid Bus bars/Switchyard Equipment Jumpers/Interconnections shall be provided subject to suitability of conductor as per specified/applicable current ratings:</p> <table border="1"> <thead> <tr> <th>Voltage Level</th> <th>Conductor / Al .Tube Type</th> </tr> </thead> <tbody> <tr> <td>Voltage Level: 765kV</td> <td>AAC Bull / 4.5" IPS Al. Tube</td> </tr> <tr> <td>Voltage Level: 400kV</td> <td>ACSR Bersimis / 4.5" IPS Al. Tube</td> </tr> <tr> <td>Voltage Level: 220kV</td> <td>ACSR Moose / 4.0" IPS Al. Tube</td> </tr> <tr> <td>Voltage Level: 132kV</td> <td>ACSR Moose / 3.0" IPS Al. Tube</td> </tr> </tbody> </table> <p>For substation extension works, suitable clamps & connectors for interconnection with existing buses as per drawings shall be provided by the contractor under present scope.</p> <p>Conductor type with higher current rating than that specified above shall also be acceptable without any additional price implication. Note: For existing substation, existing conductor configuration may preferably be adopted in extn. S/s package.</p>				Voltage Level	Conductor / Al .Tube Type	Voltage Level: 765kV	AAC Bull / 4.5" IPS Al. Tube	Voltage Level: 400kV	ACSR Bersimis / 4.5" IPS Al. Tube	Voltage Level: 220kV	ACSR Moose / 4.0" IPS Al. Tube	Voltage Level: 132kV	ACSR Moose / 3.0" IPS Al. Tube
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Voltage Level: 132kV	ACSR Moose / 3.0" IPS Al. Tube														

<p>6.</p>	<p>New Clause no. 20.1</p>	<p><u>Neutral formation for Transformer(s), DELTA formation and making connection arrangement to connect spare unit in place of any unit of the bank without physical shifting and Earthing Arrangement :</u></p> <p>For Spare Unit connection to form 3-ph bank of 765kV Class Transformers with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement & Tertiary (DELTA) formation for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below:</p> <p><u>i. Neutral Formation including Neutral auxiliary bus and Earthing Arrangement</u></p> <p>The contractor shall connect the neutrals of three (3) 1-phase transformers by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare transformer can be disconnected or connected to the three phase banks. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminium tube, conductor, clamps & connectors, earthing materials, support structure, foundation bolts, hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor.</p> <p><u>ii. Tertiary Delta Formation including Tertiary auxiliary bus(Insulation level 52 kV).</u></p> <p>The contractor shall connect 33kV tertiary of single-phase auto-transformers in DELTA configuration by overhead connection to operate in 3-Ph Bank. The Delta shall be formed by 3" IPS Al tube, which shall be insulated with heat shrinkage insulating sleeve of at least 52kV class and shall be supported by structure mounted bus post insulators at suitable intervals. Jumpers (twin conductors) wherever provided shall also be insulated using suitable insulation tape or sleeve at least 52kV class at site. The minimum phase to phase horizontal spacing for delta formation shall be 1.5meter. All associated materials like bus post insulators, Aluminium tube, conductor, clamps & connectors, support structures, foundation bolts, hardware, earthing materials etc. required for tertiary delta formation shall be provided by the contractor.</p> <p><u>iii. HV & IV Auxiliary Buses (Applicable for AIS Substation)</u></p> <p>Formation of HV & IV auxiliary buses for connection of transformer 3-Phase bank with 1-Phase Spare transformer unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, foundation bolts, required for the above-mentioned arrangement shall be provided by the contractor.</p>
<p>7.</p>	<p>New Clause no. 20.2</p>	<p><u>Neutral formation for Reactor banks, connection to neutral grounding reactor through 132kV Surge arrester, connection to ground through neutral CTs and connection arrangement to connect spare reactor unit in place of any other units of the bank without physical shifting and Earthing Arrangement :</u></p> <p>For Spare Unit connection to 3-ph bank of 765kV Class Reactors with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below:</p>

		<p><u>i. Neutral Formation including Neutral auxiliary bus and Earthing Arrangement</u></p> <p>The contractor shall connect the neutrals of three (3) 1-phase reactors by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare reactor can be disconnected or connected to the three phase banks. Neutral Connections of spare unit shall be extended upto the other unit(s) by forming Neutral auxiliary bus. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminum tube, conductor, clamps & connectors, earthing materials, support structure, foundation bolts, hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor. Required Insulation level is 145 kV from individual reactor neutral to point of neutral formation. However after neutral formation, the insulation level is 36kV.</p> <p>Connection of each Line reactor bank formed under present scope to Neutral grounding reactor through 132kV Surge Arrester including NGR by passing arrangement is also under present scope.</p> <p><u>ii.HV Auxiliary Bus (Applicable for AIS Substation)</u></p> <p>Formation of HV auxiliary bus for connection of reactor 3-Phase bank with 1-Phase Spare reactor unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, foundation bolts, required for the above-mentioned arrangement shall be provided by the contractor.</p>
8.	New Clause no. 20.3	Supply & Laying of Power, Control Cables & Special Cables (if any) (including all cabling works for spare unit of transformer/reactor) along with accessories for power supply, alarm, trip, control & indication, status and monitoring signals & contacts made available at MB/CMB of Transformers/Reactors upto Control & Relay Panels and BCUs located in the Switchyard Panel Room/Control Room and successful integration of same with Station Control, Protection & SAS System is in the scope of the contractor.
9.	New Clause no. 20.4	3½Cx300 Sq. mm XLPE power cable for oil filtration units of reactors & transformers shall be provided. The cable shall be terminated at 250A receptacle near Reactor & Transformer in the switchyard. XLPE Power cables shall be looped in & out for 250A Power receptacles.
10.	New Clause no. 20.5	Neutral of spare transformer/reactor is to be connected to station grounding system through a jumper/copper flat. This shall be applicable for single phase transformer/reactor wherever spare unit have been provided.
11.	New Clause no. 20.6	Tertiary connections made for tertiary loading of LT Transformer shall be insulated using suitable insulation tape or sleeve of at least 52kV class at site
12.	New Clause no. 20.7	The earthing risers from terminal of Neutral Current Transformer (NCT) of bank of 1-Phase Transformer/Reactor (as applicable) shall be brought down for connection with pipe electrodes by providing suitable insulators mounted on NCT support structure (minimum 2 nos. per support). Necessary provisions on NCT support structure for mounting of insulator shall be provided. These

		insulators shall deemed to be included in corresponding Erection Hardware item for Transformer/Reactor bay (as applicable) of BPS
13.	New Clause No. 21	Connection arrangement of 765kV equipment's shall be done as per the conceptual drawing (Drawing No. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS, Rev-01) enclosed as Annexure-S3 of this Section.
14.	New Clause No. 22	For connection to HV bushing of LT Transformer, insulated copper rod/strip of at least 75 sq.mm cross sectional area shall be used.
15.	New annexure	Refer Annexure-S4 for SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE
O. Section: Structure Rev 06		
1.	New Clause No. 3.2.4 Added	POWERGRID will issue the fabrication drawings of the standard structures to the successful bidder. The contractor shall do the proto assembly of the structures as per the issued fabricated drawings. Employer may opt to witness such proto assembly. The bidder shall follow the fabrication drawing for preparing the proto assembly and do the minor adjustments, if necessary, without affecting the strength of the structure. In case of equipment support structure, the attachment of stool and fixing of MOM box etc. shall be taken care by the contractor as per the requirement of the equipment. The proto to be witnessed and Proto corrected drawings along with BOM shall be certified by the contractor. Certified drawings and BOM shall be submitted to POWERGRID for information only. The arrangement shall however not absolve the contractor from the responsibility of supply and erection of safe sound and durable structure.
2.	New Clause no. 3.4	Nuts, Bolts and washers for all non-standard structures shall be payable as per BPS.
P. Section Civil Works Rev 11A		
1.	New Clause No. 21.0	The dewatering pump shall be Portable, Self Priming, Non clog, horizontal type monobloc pump. The Pump shall be driven by electric motor suitable for outdoor application with IP-55 degree of protection. Following are the major technical parameters for the pumps to be supplied as per BPS: (A) Pump Rating : 2 HP Flow Rate : 200-400 LPM Minimum Total Head : 12 Mtrs Voltage Range : 415 ± 10% Volts (Three Phase) (B) Pump Rating : 5 HP Flow Rate : 1000-1400 LPM Minimum Total Head : 10 Mtrs Voltage Range : 415 ± 10% Volts (Three Phase)
2.	Clause 10.5.3 of Section-Civil works Rev 11A & Clause 2.8 (b) of Section-Structures Rev 06	Factor of safety for design of tower and equipment structures and foundations: a. Factor of safety for design of tower, equipment structures shall be 1.5 under normal condition and 1.2 under short-circuit condition. b. Factor of safety for design of tower, equipment foundation shall be 1.5 in both normal and short circuit condition as per IS 456. c. Factor of safety for stability of tower, equipment foundation like overturning shall be 2 (without wind or seismic), 1.5 (with wind or seismic) for normal and short circuit condition as per IS 1904.
3.	New Clause No. 22.0	Slope Protection Works & Retaining Walls: Design & Drawings pertaining to slope protection works & retaining walls (if required) shall be developed by the contractor during detailed engineering for

		Employer's approval. The work shall be measured under respective line items of BPS.
4.	New Clause of Copy right in Civil Rev 11A & Structure Rev 06	<p>a. The copyright in all drawings, documents and other materials containing data and information for such design(s) to be developed by the Contractor or through any third party under this Contract shall remain vested in the Employer for a period of 5 years from the date of Completion of the Contract. In case the Contractor intends to use these design(s) for any purpose other than for project(s) to be executed by POWERGRID prior to the period of 5 years as above, the Contractor shall obtain a written permission from POWERGRID to this effect. The permission shall be granted or otherwise by POWERGRID keeping in view the specifics of the case and POWERGRID shall be sole judge in this regard.</p> <p>In case any breach of the aforesaid provisions of copyright during the copyright retention period comes to the notice, POWERGRID shall take the action as deemed fit keeping inter-alia under the provisions of the Integrity Pact.</p> <p>b. The Contractor may also use previous structure designs and associated foundation designs meeting specification requirements, which have been designed by them for any other project of POWERGRID, having copyright retained thereof with POWERGRID, without any financial implication and without any written permission from POWERGRID as per para (a) above.</p> <p>c. In case the Contractor uses previously designed structure and associated foundation designs meeting specification requirements, developed by the Contractor for any other utility/developer, POWERGRID shall be free to use designs and reproduce all drawings, documents and other material for the purpose of the Contract including, if required, in its any other project and for operation and maintenance, without any financial implication. The contractor shall ensure to submit only those documents for which they hold copyright.</p> <p>d. Also, all the drawings indicated at (a) & (b) above shall carry the following statement and shall be displayed conspicuously on the drawing:</p> <p>“WARNING: THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH POWERGRID UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM POWERGRID IN WRITING”</p>
Q.	Section CRP Rev 09	
1.	New Para added under Clause No.5.1	Requirement of Shrouding shall not be applicable to TB's where live parts are concealed.
2.	New para added under Clause no.18.8	Line Differential relays used as both Main –I & Main-II protection of a line, shall be of either different make & model or shall be on different hardware platform.
3.	New para added under	Directional Earth Fault Relay/Function provided shall have Carrier Aided scheme feature which shall be suitable for single phase auto re-closure schemes

	Clause no.18.9(s)																			
4.	Clause no. 19.1. (a), (b) and (d)	a) have single phase & 3 phase reclosing facilities. b) have a continuously variable dead time range of 0.1-2 seconds. (d) Auto reclose scheme shall have provision of selection of the following modes:- i. Single phase. ii. Three Phase. iii. Single & three phase. iv. Non-Auto The necessary provision in the scheme shall be provided to select the A/R mode from both local and remote																		
5.	New Para added under Clause No. 20.4	Wherever, scope for NGR by passing is envisaged, necessary equipment, wiring etc. required for control & monitoring of 145kV Circuit Breaker for NGR by-passing arrangement shall be under contractor's scope of work. The same may be located in respective line/reactor protection panel.																		
6.	Clause No. 21.1 (e)	be suitable for individual input from associated CTs with rated CT secondary current of 1 Amp.																		
7.	New Clause No. 21.8	Back-up Impedance protection function shall be provided for 765kV & 400kV sides of 765/400/33kV ICT and for 400kV side of 400kV class ICT. This protection function can be clubbed with any other protection IED's except of Differential Protection IDC.																		
8.	Clause No. 32.9	The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following : <ul style="list-style-type: none"> • Potential free contact (Minimum pulse duration of 50 milli seconds.) • IRIG-B • RS232C • SNTP Port (at least 4 ports) • IEEE 1588 PTP (Applicable only for Process bus automation station) 																		
9.	New clause 24.3 q)	In case of extension substation with distributed bus bar protection, if Bay unit is envisaged under scope of the contract, it shall be compatible with the existing central unit. In such case type test for the bay unit once conducted shall hold good. The requirement of type test conducted within last seven years, shall not be applicable for the bay unit.																		
10.	Clause no 37. IV Breaker Relay Panel	BREAKER RELAY PANEL: The breaker relay panel shall consist of the following: <table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Description</th> <th>Qty</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Breaker failure Protection Scheme*</td> <td>1no.</td> </tr> <tr> <td>2.</td> <td>DC supply Supervision relay</td> <td>2nos.</td> </tr> <tr> <td>3.</td> <td>Trip Circuit supervision relays#</td> <td>6nos.</td> </tr> <tr> <td>4.</td> <td>Auto-reclose scheme (##)</td> <td>1No.</td> </tr> <tr> <td>5.</td> <td>Flag relays, aux relays, timers, trip relays as per scheme requirements</td> <td>As required</td> </tr> </tbody> </table> <p>Note-1) # Trip supervision relays shall be 2 or 6 numbers as per no. of trip coils for each 132KV Circuit breaker</p> <p>Note- 2) Equipment/relays to be provided under CB Relay Panel may be accommodated in the Protection Panels to be provided for Transmission Line/Transformer/Reactor as applicable</p> <p>Note- 3) * In case of bay extension in existing half diameter, breaker failure relay for main CB / Tie CB shall be supplied only if BFR built-in Bus Bar protection bay unit is not available or Tie CB standalone BFR relay is not available in the existing protection scheme.</p>	Sl. No.	Description	Qty	1.	Breaker failure Protection Scheme*	1no.	2.	DC supply Supervision relay	2nos.	3.	Trip Circuit supervision relays#	6nos.	4.	Auto-reclose scheme (##)	1No.	5.	Flag relays, aux relays, timers, trip relays as per scheme requirements	As required
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		Note-3)	## Auto reclose scheme shall also be acceptable as a part of BCU. All Circuit Breaker Relay Panel shall be provided with Auto-reclose function. However, during execution stage Auto-reclose function shall be enabled/ disabled based on requirement
R. Section SAS Rev 04			
1.	Typical Architectural Drawing of SAS (Without Process Bus)	TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) stands replaced by <u>Annexure-S5</u>	
2.	Para 2 under Clause No. 3.3.1	The Substation Automation System shall have communication ports on each gateway (two gateways per station) as follows: (a) Three ports for Remote Control Centres on Secure IEC60870-5-104 protocol. (b) Two port on IEC 60870-5-104 for Regional System Coordination Centre (RSCC)	
3.	New Para Added Under Clause No.4.1.5	The bidder shall also provide 2 Nos. managed Ethernet switches with at least 16 copper RJ45 ports on each switch to form managed "Redundant System LAN" for connecting different NTAMC sub-systems devices (SCADA Gateways, VMS, VOIP etc.) as per revised system architecture (<u>attached as Annexure S5</u>). The specification of the switches is enclosed at <u>Annexure-S6</u> .	
4.	Para 2 Under Clause No.4.1.6	Contractor shall provide 2 nos. Next Generation Firewalls (NGFW); one No. Main & one No. Standby having electrical ethernet interfaces/ports and placed between FOTE & SAS gateways, NTAMC switch etc. at the substation. All ethernet based applications (e.g. PMU, AMR, VOIP, SAS/SCADA etc.) shall be terminated in the firewall ports directly. Each port of firewall shall work as a separate zone. Firewall shall be hardware based with functionality of Block/Allow/drop and IPSec VPN (network encryption). Minimum 16 Nos. of ports/interfaces shall be provided in each firewall (i.e. Main & Standby) Contractor can use either single firewall or multiple firewalls to meet this interfaces requirement, each for main as well as standby firewall. Minimum throughput of firewall shall be 300 Mbps. The Firewall shall be managed/ configured as standalone at present and shall also have compatibility to manage/configure through Centralized Management Console (CMC) remotely in future. OEM Support on 24x7 basis for 7 years shall be provided for all the functions & features of the Firewall. Firewall shall be tested and certified for ISO15408 Common Criteria for least EAL4+. Further, the OEM must certify that it conforms to Secure Product Development Life Cycle requirements as per IEC62443-4-1. The firewall shall generate reports for NERC-CIP Compliance. The specifications for the firewalls are attached at <u>Annexure-S7</u> .	
5.	Para 3 Under Clause No.4.1.6	The substation routers shall have the following features: <ul style="list-style-type: none"> - Routing protocols such as OSPF and support for IPv4 and IPv6 - 8 Ethernet interfaces of 10/100 Mbps - 2 E1 interfaces - Hot standby operation with a similar router - Support IEEE 802.3u, 802.1p, 802.1Q, 802.1d, 802.1w, - Traffic prioritization for routed IP flows/ports 	
6.	Bullet no.4 under Clause No. 4.2.1	Each BCU shall be equipped with Local HMI (display) facilities, enabling control of each particular bay from BCU whenever required. The Local HMI facilities shall be accomplished by means of Graphical LCD display embedded into the front panel of the BCU. Display will show the SLD (with device identification number) showing status of bay switching equipment (such as circuit breaker, isolators, earth switches) and enabling issuance of switching controls. Other display type will be multiple displays of analog values readings / reports, displays for controls other than switching, Alarm panel displays,	

		Diagnostic/ online configuration displays etc. Bay control unit shall have inbuilt metering CVT supervision function. It shall have feature to give alarm in case of CVT/PT metering core fuse fail.
7.	Clause 4.2.2 New bullet	Bay Control Units for Main System and Auxiliary system at a station shall be classified as below based on it's application and Contractor shall supply following types of BCU applicable under the subject package: Bay control Unit (IED) of Main System (a). Main Bay BCU (b). Tie Bay BCU (c). Switchable Line Reactor Bay BCU Bay control Unit (IED) of Auxiliary System (a) Auxiliary BCU
8.	New Clause 15.4	Mandatory spares: a. Mandatory Spares for Substation Automation shall be supplied as per BPS. b. The offered "Bay control Unit (IED) of Main System" as spare, shall be sufficient to replace all types of Bay control Units supplied under Main system without addition of any hardware/module etc. Further any additional I/O module and/or hardware supplied under Main system to meet the functional requirement of Bay control Unit in any bay, shall be considered part of Bay control Unit (IED) of Main System. The offered "Bay control Unit (IED) of Auxiliary System" as spare, shall be sufficient to replace all types of Auxiliary BCU supplied under Auxiliary system without addition of any hardware/module etc. Further any additional I/O module and/or hardware supplied under Auxiliary system to meet the functional requirement of Bay control Unit shall be considered part of Bay control Unit (IED) of Auxiliary System
9.	Clause No. 16.0 (v)	<u>LIST OF EQUIPMENTS</u> v) Two nos. Disturbance Recorder/Engineering Workstation where atleast one workstation shall have Linux based operating system.
S.	Section PLCC Rev 05	
1.	New Clause No. 6.12.4	For 765 kV Wave Trap, cantilever strength of BPIs used for Wave Trap shall be 10 kN.
2.	New Clause no. 10.4.13	All protection couplers (Analog protection coupler, digital protection coupler) shall be equipped with direct reading type counter facility for all the codes (Tx & Rx).
3.	New Clause no.10.5	Digital protection coupler (DPC) shall be used as one of the two tele-protection channel on the lines between the stations having Optical Fiber link alongwith SDH Equipment. Specification of digital protection coupler is enclosed as <u>Annexure-S8</u> . The DPC can be housed either in offered Control & Protection Panel / PLCC Panel or in separate panel. Generally SDH Equipment are placed in communication room of Control room where as DPC is placed in panel room. The connection between SDH equipment and each DPC shall be through Optical fiber. Necessary cables, converter(s) for converting E1 signal to optical fiber at both ends (at Panel Room as well as at Control room) along with FODP shall be in the scope of the contractor. Further sharing of additional spare ports of converter for DPC placed in other Panel Room or in same Panel Room is also permitted. Necessary optical fiber for interconnection of DPC is to be provided by the contractor. Further any copper wiring for ensuring the protection signaling/data/speech shall be in the scope of the contractor.
T.	VISUAL MONITORING SYSTEM (if specified in BPS)	
1.		Technical Specification for Visual Monitoring System for watch and ward of substation premises is attached at <u>Annexure-S9</u>

U. Section –400KV Transformer Rev 13																										
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2.	Clause No. 7.5.1	<p>Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be installed to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.</p> <p>Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.</p> <p>Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and socket with cable at site is not acceptable.</p>															
3.	Annexure-I	<p>ANNEXURE - I</p> <p>1.1 KV GRADE POWER & CONTROL CABLES</p> <p>...</p> <p>...</p> <p>STANDARD TECHNICAL DATA SHEET (1.1kV GRADE XLPE POWER CABLES)</p> <p>– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</p> <p>STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC POWER CABLES)</p> <p>– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</p> <p>STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC CONTROL CABLES)</p> <p>– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</p>															
4.	Clause no 8.1	<p>Particles in the oil</p> <p>The particle analysis shall be carried out in an oil sample taken before carrying out FAT at manufacturer's works and after completion of the oil filtration at site. The procedure and interpretation shall be in accordance with the recommendation of CIGRE report WG-12.17- "Effect of particles on transformer dielectric strength". Particle limit as shown below shall be ensured by manufacturer, implying low contamination, as per CIGRE Brochure 157, Table 8.</p> <p>Limiting value for the particle count are 1000 particle/100 ml with size $\geq 5 \mu\text{m}$; 130 particle/100 ml with size $\geq 15 \mu\text{m}$.</p>															
5.	Annexure-C	Sl. nos. (i) and (iii) of Reference Drawings mentioned at Annexure-C stands deleted.															
Y	LT transformer Rev-5																
1.	Clause no 5.2.5 b)	Clause no 5.2.5 b) Stand Deleted.															

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) Annexure K (Rev 01)

Sl. No.	Power System Equipment	Minimum Local Content (%)
1	Power Transformers (up to 765 kV, including Generator Transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (Up to 400kV)	60
6	Resin Insulated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765kV AC-Alternating Current)	60
8	Disconnectors, Isolators (up to 765kV AC)	60
9	Wave Trap (up to 765kV AC)	60
10	Oil Filled Distribution Transformers up to & including 33kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry type Distribution Transformers up to & including 33kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional conductor	60
13	Accessories for conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and accessories	60
15	Optical ground wire (OPGW)- all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and accessories	60
18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33kV	60
20	Control cables including accessories	60
21	XLPE cables up to 220kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Long Rod Insulators with Room temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BFD)	60
32	Power Line Carrier Communication (PLCC) system (up to 800kV)	60
33	Gas Insulated Switchgear (up to 400kV AC)	60
34	Gas Insulated Switchgear (above 400kV AC)	50
35	Surge/Lightning Arrester (up to 765kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6kV to 33kV)	60
38	Ring Main Unit (RMU) (up to 33kV)	60

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) Annexure K (Rev 01)

39	Medium Voltage (MV) GIS panels (up to 33kV)	60
40	Automation and Control system/Supervisory Control and Data Acquisition (SCADA) system in Power system	50
41	Control and Relay panel (including Digital/Numerical relays)	50
42	Electrical motors 0.37kW to 1MW	60
43	Energy meters excluding smart meters	50
44	Control and Power cables and accessories (up to 1.1kV)	60
45	Diesel Generating (DG) set	60
46	DC system (DC Battery & Battery Charger)	60
47	AC and DC Distribution board	60
48	Indoor Air Insulated Switchgear (AIS) up to 33kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxiliary Relays	50
55	Load Break Switch	50
56	Cranes, EOT cranes, gantry crane & chain pulley blocks, etc	60
57	Elevator	60
Fire Protection and Detection system		
58	Motor driven fire water pumps	60
59	Diesel engine driven fire water pumps	60
60	Hydrant system	60
61	High velocity water spray system	60
62	Medium velocity water spray system	60
63	Foam Protection system	60
64	Inert gas flooding system	60
65	Fire tenders	60
66	Portable fire-extinguishers	60

Annexure-V (Revised): Actions required in case of defects observed during warrantee period

Equipment	Nature of problem	Corrective measures to be taken by contractor
CT/IVT/PT (Oil filled)	DGA Violation H ₂ > 300 ppm C ₂ H ₂ > 2 ppm	Refurbished or replaced
CT/IVT/PT (SF ₆ filled)	a) SF ₆ gas leakage b) High Dew point of SF ₆ gas (> -36 deg C at atm press)	a) Repair/ replacement b) Re-processing of gas and replacement of Gas in case of no improvement
CT/IVT/PT (Oil filled)	Violation of Tan delta Tan Delta: >0.5% (during pre-commissioning) >0.7% (in operation) or change w.r.t. to previous year value > 0.1%	Replacement
CT, IVT/PT & CVT	- Oil leakage - Low Oil level - Sec winding problem leading to open/ short circuit, saturation etc	Replacement or repair as per repair procedure approved by QA.
CVT	Secondary voltage drift: Upto ± 0.5 volts Healthy a) ± 0.5 or beyond	a) CVT to be replaced

***Replaced/Repaired/Refurbished Equipment (or part of equipment) shall have 2 years warranty without prejudice to contractual warranty period.**

TECHNICAL DATA SHEETS
DATA SHEET FOR DELUGE VALVE

1.0	Manufacturer	POWERGRID Approved make
2.0	Number & size	As per approved system drawings.
3.0	Type	Differential Diaphragm type
4.0	Rating	
4.1	Flow in M ³ /hr. 1. 150 mm ø 2. 100 mm ø	170 to 650 50 to 225
4.2	Pressure	Working Pressure – 12.3 kg/cm ² Test Pressure - 25 kg/cm ²
4.3	Pressure drop in equivalent length 1. 150 mm ø 2. 100 mm ø	19M 11M
5.0	Material of construction	
5.1	Body	CI IS:210 Gr. FG 260
5.2	Valve internal	Cast Bronze – IS:318-LTB 2 / Ductile Iron ASTM A536 65-45-12
5.3	Seat Seal	EPDM/ Neoprene Rubber
5.4	Diaphragm	EPDM/ Neoprene Rubber
6.0	Differential pressure required for operation	Differential Ratio – 50%
7.0	Water Motor Gong provided	Yes
7.1	Type	Hydraulic type
7.2	Material of Construction:	
7.2.1	Housing	Al. Alloy-IS:617
7.2.2	Cover/Rotor./Gong	Aluminium to IS:737
7.2.3	Manual actuation lever provided?	Yes
8.0	Remote actuation with Solenoid Valve provided?	Yes
9.0	Resetting type	Manual resetting type
10.0	Deluge valve complete with test and drain valves, manual operation arrangement, supporting structures and all necessary accessories	Yes
11.0	Approval of Deluge Valve.	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

METHODOLOGY FOR SUPPLY, INSTALLATION & SIZING OF CABLES**Supply of 1.1kV grade Cables:**

- The quantities of various type of 1.1kV grade power and control cables shall be assessed by POWERGRID. The Sizes of 1.1 kV grade Control cables to be adopted for installation is enclosed at Appendix I . For Sizes of Power Cable, Clause 1.1.4 of Section Power and control Cable rev 06 is amended at Appendix-II

For Applications in addition to those specified, appropriate cable size shall be considered by the contractor with prior approval of Employer during execution stage

- Supply of 1.1kV grade power and control cables of various sizes shall be as per unit quantities mentioned in BPS.
- The Cables from Control Room/SPR/ACDB/DCDB/BMK to Equipment Marshalling box (MB)/Local control Cubical (LCC) shall be considered under the BPS item for supply of cables.
- The Interpole cables between AIS Instrument Transformer (CT/CVT), Surge Arrester and associated Junction Box shall be as per unit quantities mentioned in BPS.
- The Interpole cables between Circuit Breaker, Isolator and associated Marshalling box shall be deemed to be included in price of Equipment.

Installation of 1.1kV grade Cables:

- The quantity of Installation of cables is to be assessed by the contractor for the complete scope of work specified in Section project.
- The installation of 1.1kV grade power and control cables (including interpole cable of Equipment & illumination cables) shall be quoted in "LOT" basis.
- Supply and installation of Cable accessories like lugs, glands etc. for entire cabling work shall be deemed to be included in Installation charges of cables quoted by contractor in Bid price schedule.
- No variation shall be admissible on account of Installation of Cables/supply and installation of associated accessories, irrespective of variation (either positive or negative) in supply quantity of Cable specified in BPS.

Extra Consumption of 1.1 kV Power and control cables.

The Contractor shall make every effort to minimise wastage of the cables during installation. The Permitted Overall scarp/wastage shall be limited to 0.50% of actual supplied quantity for each size of cables. Any wastage more than the above limit shall be recovered from the contractor. All balance unused cables shall be returned to the employer by rewinding in separate drums for each size with discrete markings on drums.

Cut pieces of Cables having length less than following shall be considered for Scrap. The Contractor shall dispose of the scrap (if any), at their own cost :

1.) Length less than 20 M

- a) Control Cable (3C, 5C, 7C & 10 Core)
- b) Power Cable(2CX 6Sqmm,4CX6Sqmm, 4CX16Sqmm)

2.) Length less than 50 M

- a) Control Cable having more than 10 Cores
- b) Power Cable of sizes above 16 Sq mm

For Illumination purpose, ACP's shall be supplied as per BPS. From ACP to luminous all the required cables, accessories(including lugs and gland for cables between MLDB & ACP) , SLP/JB etc as required shall be assessed and supplied by the contractor. The price of these items shall be deemed to be included in price of luminaries.

Appendix-I: Control Cable Sizes

S.No.	From	To	Proposed Cable size
1.	CB MB	CRP panels	i) 10CX2.5Sq mm ii) 19CX1.5 Sq mm iii) 27CX 1.5 Sq mm
2.	CB MB	Earth switch MB	i) 3CX 2.5 Sqmm ii) 5C X2.5 Sq mm
3.	Isolator MB	Earth switch MB	10CX2.5Sq mm
4.	Isolator MB	CRP panels	19CX1.5 Sq mm
5.	CT	CT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
6.	CT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
7.	CVT	CVT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
8.	CVT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
9.	LA	LA JB	3C X2.5 Sq mm
10.	LA JB	CRP panels	5C X2.5 Sq mm
11.	Reactor MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX2.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables
12.	ICT MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX2.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables

Note:

- i) For Applications in addition to those specified, appropriate cable size shall be considered by the contractor with prior approval of Employer during execution stage.
- ii) GTP of 1.5 Sq mm Cable shall be submitted during detailed engineering stage for employers approval.
- iii) In case, more nos. of runs or larger sizes of cables are required between two points based on design calculations, same shall deemed to be included in the scope of bidder.

Appendix-II Power cable sizes.

S.No.	From	To	Existing Cable size	Cable type
1.	Main Switch Board	LT Transformer	2-1C X 630 mm ² :For each phase 1-1C X 630 mm ² : for neutral	XLPE
2.	Main Switch Board	AC Distribution Board	2-3½C X 300 mm ²	XLPE
3.	Main Switch Board	Oil Filtration Unit	1-3½C X 300 mm ²	XLPE
4.	Main Switch Board	Colony Lighting	1-3½C X 300 mm ²	XLPE
5.	Main Switch Board	HVW pump LCP	1-3½C X 300 mm ²	XLPE
6.	Main Switch Board	Main Lighting distribution board	2-3½C X 300 mm ²	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	For 500 kVA DG set: 2-3½C X 300 mm ² For 250 kVA DG set: 1-3½C X 300 mm ²	XLPE
8.	AC Distribution Board	Emergency Lighting distribution board	3½C X 70mm ² :For 765/400kV S/s 3½C X 35mm ² :For 400/220kV S/s	PVC
9.	AC Distribution Board	ICT MB	3½C X 70mm ² :For 765/400kV S/s 3½C X 35mm ² :For 400/220kV S/s	PVC
10.	AC Distribution Board	Bay MB	3½C X 70mm ² :For 765/400kV S/s 3½C X 35mm ² For 400/220kV S/s	PVC
11.	Bay MB	AC Kiosk	1-4C X 16 mm ²	PVC
12.	AC Distribution Board	Battery Charger 220 V	1-3½C X 70 mm ²	PVC

13.	AC Distribution Board	Battery Charger 48 V	1-3½C X 35 mm	PVC
14.	DCDB	Battery	2-1C X 150 mm ²	PVC
15.	DCDB	Battery Charger	2-1C X 150 mm ²	PVC
16.	DCDB	Protection/PLCC panel	1-4C X 16 mm ² : 765/400kV S/s 1-4C X 6 mm ² : 400/220kV S/s	PVC
17.	Main Lighting DB	Lighting panels(Indoor)	1-3½C X 35 mm ²	PVC
18.	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm ²	PVC
19.	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm ²	PVC
20.	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm ²	PVC
21.	Lighting Panel	Sub lighting panels	These Cables shall be included in Price of item for Lighting fixture	PVC
22.	Lighting Panel	Street Lighting Poles	These Cables shall be included in Price of item for Lighting fixture	PVC
23.	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	These Cables shall be included in Price of item for Lighting fixture	PVC
24.	Bay MB	Equipment	1-4C X 16 mm ² : For CB 1-4C X 6 mm ² : For Isolator/earths switch 1-2C X 6 : For CT/CVT	PVC
25.	ELDB	Lighting panel	3½C X 70mm ² :For 765/400kV S/s 3½C X 35mm ² :For 400/220kV S/s	

AIR CONDITIONING & VENTILATION SYSTEM FOR GIS BUILDING

AIR CONDITIONING SYSTEM FOR GIS

1. GENERAL

- 1.1. This specification covers supply, installation, testing and commissioning and handing over to POWERGRID of Air conditioning system for the Local Control rooms & Maintenance Room in the GIS halls.
- 1.2. Air conditioning system shall be designed to maintain the inside DBT below 24oC. Bidder shall submit necessary design calculations for employer's approval.
- 1.3. At least 50% spare Air-Conditioning capacity shall be provided for Local Control rooms in the GIS halls.
- 1.4. Controllers shall be provided in Local Control room inside GIS hall for controlling and monitoring the AC units in these rooms as detailed in clause no.2.6.
- 1.5. Each Local Control room inside GIS hall shall be provided with temperature transducer to monitor the temperature of the Local Control rooms in the GIS halls. The Temperature transducer shall have the following specification.

Sensor	: Air temperature sensor (indoor use)
Output	: 4 to 20mA
Temperature range	: -5°C to 60°C
Resolution	: 0.1°C
Accuracy	: 0.5°C or better.

2. AIR CONDITIONING SYSTEM REQUIREMENTS.

- 2.1. Air conditioning requirement of the buildings shall be met using a combination of following types Air Conditioning units as required.
 - a) Cassette type split AC units of 3TR.
 - b) High wall type split AC units of 2TR
- 2.2. Type & Capacity of air conditioners shall be so chosen such that quantity of air conditioners in the room is optimized keeping the necessary air flow.
- 2.3. **SCOPE**
The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

- 2.3.1. Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.
- 2.3.2. Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.
- 2.3.3. Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.
- 2.3.4. First charge of refrigerant and oil shall be supplied with the unit.
- 2.3.5. GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.
- 2.3.6. Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.
- 2.3.7. All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.
- 2.3.8. PVC drain piping from the indoor units upto the nearest drain point.
- 2.3.9. Supply and erection of Power and control cable and earthing.
- 2.3.10. MS Brackets for outdoor condensing units, condensers as required.

2.4. Technical specifications

2.4.1. Cassette type split AC units

The Cassette type AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

- 2.4.1.1. Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.
- 2.4.1.2. Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode etc.
- 2.4.1.3. Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have energy efficiency rating of 4 star as on the date of NOA.

2.4.2. High wall type split AC units.

The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.4.2.1. Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.4.2.2. The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

2.4.2.3. Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 4 star as on the date of NOA

2.5. Controllers shall be provided in Local Control room inside GIS hall, one controller for each room, to control and monitoring of AC units and shall have the following facilities.

- Standby units shall come in to operation automatically when the running main unit fails.
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:
 - a. Compressor On/OFF condition of each unit
 - b. Compressor failure of each unit
 - c. Power OFF to AC unit
 - d. High temperature in room

2.6. Warranty

All compressors shall have minimum 5 years Warranty from the date of commissioning.

Ventilation system for GIS Hall

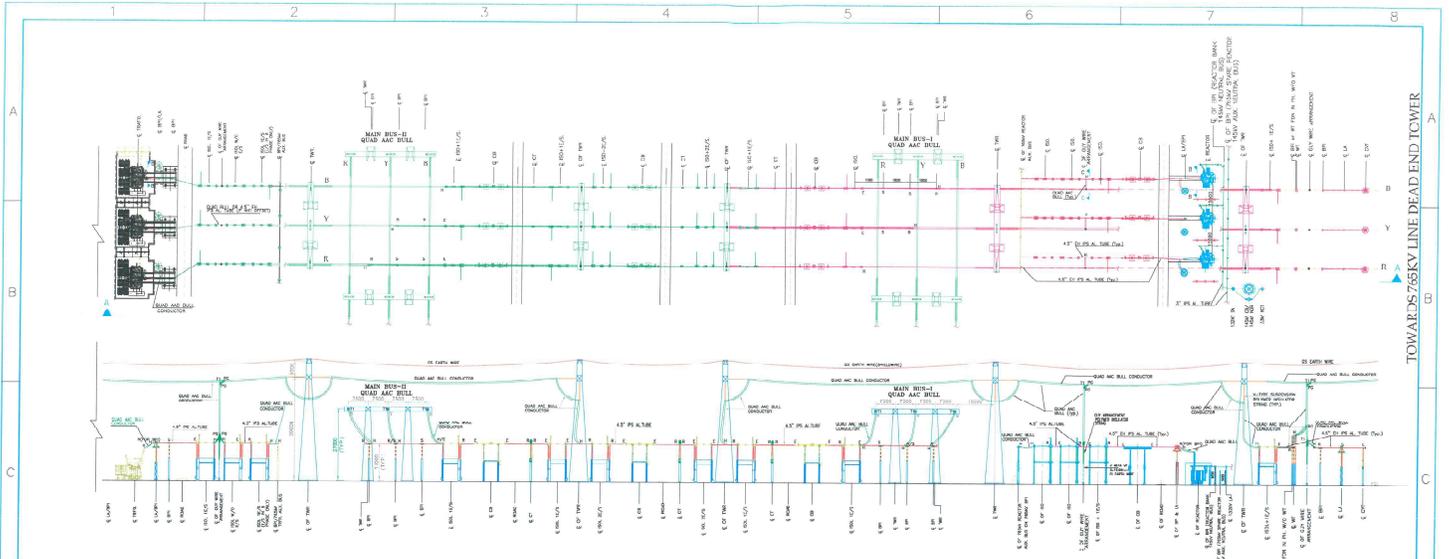
Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

1. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.
2. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

The ventilation of the GIS hall shall be of a positive pressure type with minimum 2 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.



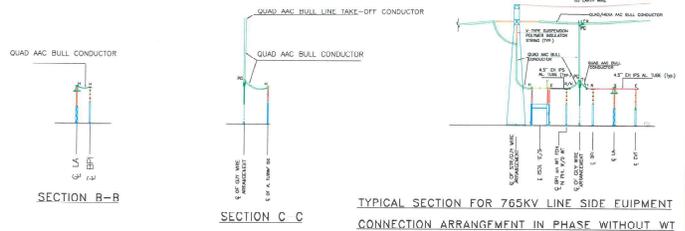
SECTION A-A (TYPICAL PLAN & SECTION FOR 765kV SIDE OF 765/400/33kV ICT -TIE-765kV LINE WITH LINE REACTOR BAY)

LEGENDS:

- R- RIGID CONNECTION
- E- EXPANSION TYPE CONNECTION
- S- SLIDING TYPE CONNECTION
- PG-PARALLEL GROOVE CONNECTION
- T1- T1 TYPE CONNECTION (EACH T CONNECTOR SHALL BE OF TWIN TO TWIN CONDUCTOR TYPE FOR QUAD TO QUAD CONNECTION)
- H- HORIZONTAL TYPE CONNECTION

NOTES

- 1) TWIN-TWIN CONNECTOR SHALL BE USED FOR QUAD-QUAD DROPPER CONNECTION.
- 2) AUXILIARY BUS ARRANGEMENT FOR 765KV TRANSFORMERS & REACTOR NEUTRALS, SPARE TRANSFORMER/REACTOR CONNECTION, TERTIARY ARRANGEMENT OF TRANSFORMERS ARE NOT SHOWN COMPLETELY.
- 3) CANTILEVER STRENGTH OF 765KV INSULATORS/BPI USED FOR 765KV ISOLATORS/WT SHALL BE OF 10KN AND FOR OTHER BPI IN SWITCHYARD SHALL BE OF 8KN MINIMUM.
- 4) HORIZONTAL TAKE-OFF OF JUMPERS AT EQUIPMENT LEVELS WITH ADEQUATE SAG SHALL BE PROVIDED



POWER GRID CORPORATION OF INDIA LIMITED
(A Company of India Enterprise)

1111: CONCEPTUAL CONNECTION ARRANGEMENT OF HEAVY TRANSFORMER BAY-TIE BAY- LINE WITH LINE REACTOR BAY

DRAWING NO. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS	REV: 1 SBL1091
--------------------------------------------------------	-------------------

<i>Shyam</i> GAUTAM SHARMA CBE (ENGG-S/S)	<i>D.O.Jha</i> D.O.JHA DCM (ENGG-S/S)	<i>A.Sambal</i> A.SAMBALIAH DCM (ENGG-S/S)	<i>Abhay</i> ABHAY KUMAR Sf. GM (ENGG-S/S)	<i>P.K. Das</i> P.K. DAS Sf. GM (ENGG-S/S)	<i>Rajil</i> RAJIL SRIVASTAVA CCM (ENGG-S/S)	<i>R.N. Singh</i> R.N. SINGH ED (ENGG-S/S/T/L & CIVIL)
PREPARED BY			REVIEWED BY		APPROVED BY	

SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE

For new 765kV and 400 kV AIS switchyard with one & a half breaker switching scheme, three gantry type arrangement (i.e. arrangement having single gantry in Tie bay) shall be considered. Further, Short-Circuit Forces (SCF) for the design of Gantry Structure and spacer spans shall be as mentioned below:

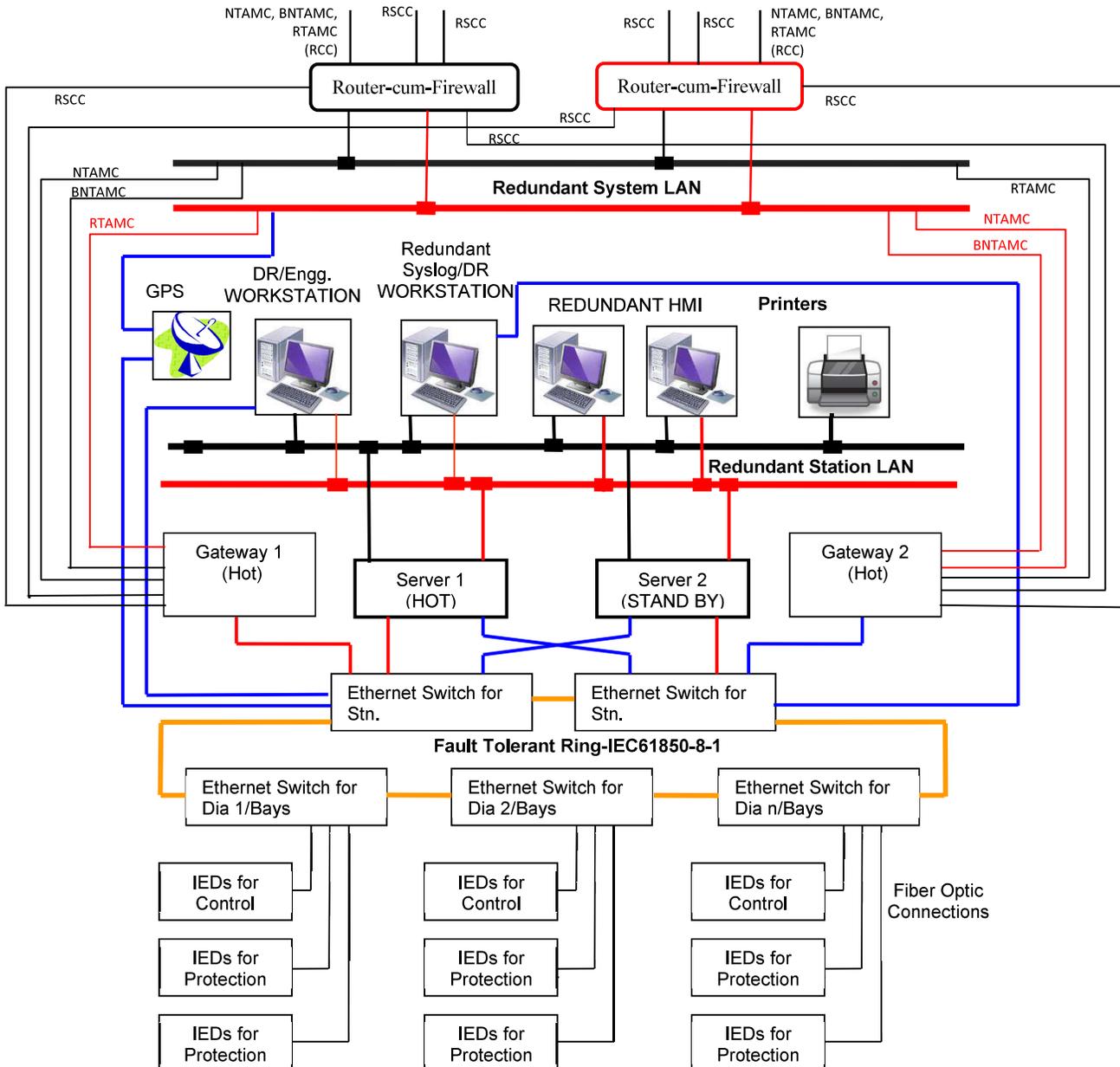
Voltage Level: 765kV, Fault Level: up to 50kA for 1 sec								
Bus Type	Height of Bus (from FGL)	Max Span	Bus Conductor Configuration	Ph-Ph Spacing	Normal Tension per phase	SCF per phase	Spacer Span	Applicable Wind Speed
Main Bus	27 Mtr	108 Mtr	Quad Bull	15Mtr	8T	9.75T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	140 Mtr		15Mtr	9.5T	11.26T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	114 Mtr		15Mtr	9.5T	11.10T	6Mtr	Upto 50m/s
Voltage Level: 400kV, Fault Level: up to 63kA for 1 sec, Bay Width : 24 Mtr								
Bus Type	Height of Bus (from FGL)	Max Span	Bus Conductor Configuration	Ph-Ph Spacing	Normal Tension per phase	SCF per phase	Spacer Span	Applicable Wind Speed
Main Bus	15mtr	72.0Mtr	Quad Bersimis	6.5mtr	5T	7.32T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	4Mtr	Upto 47m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	3.5Mtr	Upto 50m/s
Jack Bus	23Mtr	59.0Mtr		6.5mtr	5T	7.12T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	46.0Mtr		6.5mtr	4T	6.20T	4Mtr	Upto 50m/s

Above shall also be applicable for following cases unless otherwise specified elsewhere:

- (i) Extension of 765kV switchyard with existing three gantry type arrangement
- (ii) Extension of 400kV switchyard with existing three gantry type arrangement and having bus heights matching with above.

For design of gantry structures with spans, wind speed or conductor configurations other than that mentioned above, conductor tension shall be considered based on actual requirement of present & future scope of work. Relevant design calculations for such cases shall be submitted by the contractor for employer's approval.

TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) for New Substation



Note:

1. The redundant managed bus (station LAN) shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
2. Inside the sub-station, all connections shall be realized as per IEC 61850 protocol.
3. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-104 protocol. The number of ports required shall be as per clause no. 1.1 and 3.3 of this specification.
4. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder work stations.
5. The above layout is typical. However if any contractor offers slightly modified architecture based on their standard practice without compromising the working, the same shall be subject to approval during detailed engineering.
6. RCC means NTAMC/RTAMC. Similarly, RSCC could be SLDC for state owned substations/bays.
7. Syslog server to be Linux based. However DR/Engg. PC workstation can be other Operating System.

SPECIFICATION FOR SWITCHES**Substation System LAN:**

2 (two) nos. managed Ethernet switches with 16 copper 10/100 Mbps RJ45 ports on each switch shall be supplied to form redundant system LAN as shown in typical architecture drawing. These switches shall be different from IEC 61850 LAN and specifically used for the purpose of connecting various devices of different sub-systems (SCADA, VMS, VOIP etc.) for integration with NTAMC/RTAMC. These switches shall be suitable for substation environment and shall comply with the requirements of IEC 61850-3 standard for EMI/EMC.

These LAN switches shall have the following compliance and functional features:

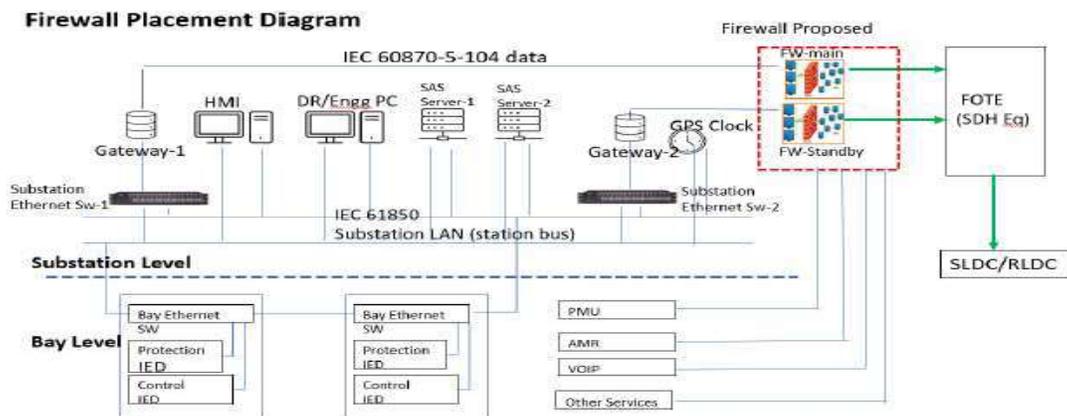
- (a) Compliance as per NERC-CIP-3, NERC-CIP-5, NERC-CIP-7 standard for cyber security
- (b) Support SNMPv3 (Full SNMP support including Traps)
- (c) Web based GUI or CLI based with HTTPS/HTTP and SSH/ Telnet support
- (d) Support for IPv4 and IPv6 switching simultaneously
- (e) Layer 3 Static routing functionality
- (f) Syslog facility for local as well as remote server
- (g) Support for remote management
- (h) LED indication for port status/supply etc.
- (i) Shall support VLAN IEEE 802.1Q
- (j) IGMP snooping
- (k) Spanning tree protocol IEEE 802.1d or RSTP IEEE 802.1w
- (l) Shall support STP
- (m) Port based Network Access Control (IEEE 802.1x)
- (n) Quality of Service (IEEE 802.1p)
- (o) Shall support unicast as well as multicast IP traffic
- (p) STP time synchronization
- (q) Shall support Mac Binding
- (r) Fanless design

Technical Specification for Next Generation Firewalls (NGFW)

1. NGFW shall have following features including but not limited to:
Encryption through IPSec VPN (Virtual Private Network), Deep Packet Inspection (DPI), Denial of service (DoS) & Distributed Denial of Service (DDoS) prevention, Port Block/ Allow, rules/policies for block/allow, IP (Internet Protocol) & Media Access Control (MAC) spoofing protection, threat detection, Intrusion Prevention System (IPS), Anti-Virus, Anti-Spyware, Man In The Middle (MITM) attack prevention.
2. The proposed firewall shall be able to handle (alert, block or allow) unknown /unidentified applications e.g. unknown TCP & UDP packets. It shall have the provision to define application control list based on application group and/or list.
3. Firewall shall have feature and also have capability to update the definition/ Signatures of Anti-Virus online as well as offline. Firewall shall also be compatible to update the definitions/signatures through CMC. There shall be a defined process for security patching and firmware up-gradation. There shall be a feature to field validate firmware checksum. The same shall also be validated before using the OEM provided file/binary in the process of firmware up-gradation and security patching
4. Firewall shall have Management Console port to configure remotely.
5. Firewall shall be EMI/EMC compliant in Substation environment as per IEC 61850-3.
6. Firewall shall be rack mounted in existing standard equipment cabinets.
7. Firewall shall have support of SCADA applications (IEC-60870-5-104), ICCP, PMU (IEEE C37.118), Sub-Station Automation System (IEC 61850), Ethernet and other substation environment protocols.
8. Client based Encryption/ VPN must support different Operating System platforms e.g. Windows, Linux & Mac.
9. The solution must have content and comprehensive file detection policies, blocking the files as function of their types, protocols and directions.
10. Firewall shall have logging facility as per standard logs/events format. Firewall shall have features to export the generated/stored logs/events in csv (Comma Separated Value) and also any other standard formats for offline usage, analysis and compliance. Firewall shall have suitable memory architecture and solution to store and be enable to export all logs/events for a period of last 90 days at any given time.
11. Firewall shall have features and be compatible with local as well as central authentication system (RADIUS, LDAP, or TACACS+) for user account and access right management. It shall also have Role Based User management feature.

12. Firewall shall have the capability to configure sufficient number of VLANs.
13. Firewall shall have the capability to support sufficient number of sessions.
14. Firewall shall have provision to configure multiple IP Sec VPNs, at least 100 nos., (one-to-many or many-to-one). Shall support redundant operation with a similar router after creation of all the IP Sec VPN. IPsec VPN shall be with encryption protocols as AES128, AES256 and hashing algorithms as MD5 and SHA1. IPsec VPN throughput shall be at least 300 Mbps.
15. Firewall shall be capable of SNMP v3 for monitoring from Network Management system. It shall also have SNMPv3 encrypted authentication and access security.
16. Firewall shall operate in Active/Passive or Active-Active mode with High Availability features like load balancing, failover for firewall and IPsec VPN without losing the session connectivity.
17. Firewall should have integrated traffic shaping (bandwidth, allocation, prioritisation, etc.) functionality.
18. Shall support simultaneous operation with both IPv4 and IPv6 traffic.
19. Firewall shall be compatible with SNTP/NTP or any other standards for clock synchronization.
20. Firewall shall have the features of port as well as MAC based security.
21. Firewall shall support exporting of logs to a centralized log management system (e.g. syslog) for security event and information management.
22. Firewall time shall be kept synchronised to official Indian Timekeeping agency, time.nplindia.org.
23. Firewall product shall be provided with all applicable updates at least until 36 months since the applicable date of product shipping to the concerned utility.

Figure-1



SPECIFICATION FOR DIGITAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cablesystem

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+15%/-20%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port. It shall provide suitable interfaces for protective relays, which operate at 220V DC. Power supply points shall be immune to electromagnetic interface

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signalling equipment shall be designed and provided with following feature.

- Shall work in conjunction with SDH terminal equipment.
- It shall communicate on G 703 (E1,2 Mbps)
- Full Duplex operation
- Auto loop facility shall be provided
- Shall meet IEC 60834-1 standard
- Shall be able to transmit upto 4 commands with trip counter simultaneously or sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. With regard to trip counters alternate arrangement i.e. Laptop along with software & all accessories to download events including carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel.

Reports of the following tests as per clause 9.2 of Section-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

- i) **General equipment interface tests:-**
 - a) Insulated voltage withstand tests
 - b) Damped oscillatory waves disturbance test
 - c) Fast transient bursts disturbance test
 - d) Electrostatic discharge disturbance test
 - e) Radiated electromagnetic field test
 - f) RF Disturbance emission test
- ii) **Specific power supply test**
 - a) Specific power supply test
 - b) Power supply variations
 - c) Interruptions
 - d) LF disturbance emission
 - e) Reverse polarity
- iii) **Tele-protection system performance test:-**
 - a) Security
 - b) Dependability
 - c) Jitter
 - d) Recovery time
 - e) Transmission time
 - f) Alarm functions
 - g) Temperature and Humidity tests (As per IEC 68-2)
 - Dry heat test (50°C for 8 hours)
 - Low temperature test (-5°C for 8 hours)
 - Damp heat test (40°C/95%RH for 8 hours)

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC

60834-1 and the standards mentioned therein.

iv) **Relays**

- a) Impulse voltage withstand test as per clause 6.1 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686)
- b) High frequency disturbance test as per clause 5.2 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686).

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follow.

- i) Power supply 48V DC +15% /-20%
- ii) Number of commands 4 (four)
- iii) Operating time <7 ms
- iv) Back to back operate time without propagation delay ≤ 8 ms
- v) Interface to Protection relays

Input:	Contact Rating:	
Rated voltage	:	250
volts DC	Maximum current rating:	5
	amps	
Output:	Contact Rating:	
Rated voltage	:	250 volts DC
Rated current	:	0.1 A DC
Other parameters :		As per IEC-255-0-20
- vi) Alarm contact

Rated voltage	:	250 volts DC
Rated current	:	0.1 A DC
Other parameters :		As per IEC-255- 0-20
- vii) Digital communication interface: G 703(E1)

Technical Specification for Visual monitoring system for watch and ward of Substation premises:

Visual monitoring system (VMS) for effective watch and ward of sub station premises covering the areas of entire switchyard, Control Room cum Administrative building, Fire fighting pump house, stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor.

System with Color IP Cameras for VMS surveillance would be located at various locations including indoor areas and outdoor switchyard and as per the direction of Engineer-In-Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

1. The operation of each and every isolator pole of the complete yard in case of AIS Sub-station.
2. The Operation of each bay(s) of GIS Hall as Applicable.
3. All the Transformer and Reactors All the Entrance doors of Control Room Building and Fire-fighting Pump House, GIS Hall and Switchyard Panel room as applicable.
4. All the gates of switchyard.
5. Main entrance Gate
6. All other Major AIS Equipment (such as CB, CT, CVT, SA etc. as applicable)

The cameras can be mounted on structures, buildings or any other suitable mounting arrangement to be provided by the contractor.

1.1 Technical requirements of major equipment of Visual Monitoring System.

- 1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.
- 1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.
- 1.1.3 The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using H 264/MPEG 4 or better standard. Mouse/Joystick-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.
- 1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more

@ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.

- 1.1.5 The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System.

1.2 System requirements:

- a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.
- b) All cameras may be connected through a suitable LAN which shall be able to perform in 765kV class sub-station environment without fail.
- c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
- d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.
- e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.
- f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.
- g) In order to optimize the memory, while recording, video shall be compressed using H 264/MPEG-4 or better standard and streamed over the IP network.
- h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.
- i) The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.
- j) System shall have provision of WAN connectivity for remote monitoring.
- k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:
 1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
 2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-18
 3. AC Voltage Dips & Interruption/Variation (class 3) – As per IEC 61000-4-11
 4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
 5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
 6. Ripple on DC input Power Supply Port immunity test(level 4) - As per IEC 61000-4-17

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

- a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.
- b) The software should have inbuilt facility to store configuration of encoders and cameras.
- c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.
- d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.
- e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.
- f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.
- g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.
- h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.
- i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.
- j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 22" High resolution monitor, and Internal DVD writer. Windows XP/Vista/7 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1.	Server Spec	Intel Quad Core (or better) 3.0 Ghz (min.) , 8 MB Cache , 4 GB memory , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2.	Recording and Display Frame Rate	Real-time 25 frames per second per channel , manual select

3.	Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
4.	Compression Method	H.264/MPEG-4 or better and latest
5.	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6.	Monitoring Options	Split screen 1, 2, 4 , 8, 16, 32 or more cameras
7.	Playback Options	Search, still image capture
8.	Alarm/Event Recording Capable	To be provided with built-in external alarm input/output ports minimum(8 in, 2 out)
9.	Network Operation Capable	To be provided by using WAN or LAN router
10.	Remote Internet Viewing Capable	Using WAN or LAN router
11.	HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
12.	Operation	Triplex operation (simultaneous recording, playback, network operation)
13.	Number of Video Channel	32
14.	Audio Recording Capable	32
15.	Input Voltage	230V AC or equivalent with UPS as a back up for 30 minutes.

1.2.3 VMS Camera

- a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the POWERGRID premises as per the direction of Engineer-In-Charge
- b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit
- c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.
- d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.
- e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.
- f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux
- g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 765/400KV switchyard.
- h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password
- i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1.	Image Sensor	2-megapixel Progressive ,1 / 3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5LUX(Color) 0.05Lux(Black)
3.	Camera Enclosure Type	IP66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG 4 user selectable
6.	Support Dual-stream	primary/secondary stream, H.264/MPEG 4 optional
7.	Video Definition	Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25frames/second NTSC:1-30frames/second
10.	Video Compression BR	32Kbit/S - 6Mbit/S
11.	Video Output	One channel composite Streaming
12.	Supported Protocols	TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13.	Operating Temperature	-5 ~ +50°C
14.	Operating Humidity	10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1.	Image sensor	1/3 type Solid State Progressive Scan CCD,WDR(High Definition)
2.	Security	Multiple user access with password protection
3.	Effective Pixels	(PAL): Main Stream : 1280x720 Sub Stream : 640x360, 320x280 selectable
4.	Compression	Dual Stream H.264 and MPEG 4 user selectable
5.	Signal System	50 Hz
6.	S/N (signal to noise) Ratio	Better than 50 dB
7.	Electronic Shutter	1/60 ~ 1/10,000 sec. automatic or better
8.	Scanning System	Progressive/interlace
9.	Low Light Sensitivity (lux)	Color: 0.5 Lux; B&W:0.02 Lux
10.	Lens	Minimum 10x (minimum) optical in High Definition (The system shall be able to zoom the images on the monitor without any distortion to the maximum level of optical zoom)
11.	Lens Size	Minimum 4.1~73.8 mm
12.	Lens Aperture	F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13.	PTZ Data Transfer Baud/Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps

14.	Panning Range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degrees / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degrees / second ~ 150 degrees / second
18.	In Built Storage	Camera should have inbuilt storage TF or SD format for recording and storing Pictures
19.	IP Class	IP66 Standard
20.	Working temperature	-0°C ~ +50°C
21.	Working Humidity	10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include:

- Fully functional dynamic keyboard/joystick controllers
- Controls all pan, tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

1.	Key Application	wired keyboard control operation of PTZ functions for weatherproof dome cameras
2.	Pan / Tilt / Zoom Protocol Languages Supported	Selectable
3.	PTZ Data Transfer Baud Rates Supported	selectable 1200 bps / 2400 bps / 4800 bps / 9600 bps
4.	Additional Features	dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

Reference Guidelines for GIS Grounding

1. GIS Grounding

These reference guidelines are minimum requirement and do not override manufacturer's recommendations or design criteria. These Reference Guidelines shall be read and implemented in conjunction with manufacturer recommendation/Criteria for GIS grounding design.

GIS Grounding system shall be designed to provide low-impedance grounding path for ground fault currents. Very Fast Transient generated due to electrical breakdown in the insulating gas, either across the contacts of a switching device during operation or under fault conditions shall also need to be considered in the overall grounding design for GIS. Grounding conductors or system of conductors shall be provided for connecting all designated metallic components of gas-insulated substation (GIS) to a substation grounding system.

1.1. Power Frequency Grounding: Manufacturer recommended designated grounding points of GIS equipment shall be connected with the risers directly coming from buried main GIS grounding mat. The Size of the conductor (copper) for making this connection shall be submitted by GIS manufacturer based on the specified fault current and its duration. The location and numbers of above said risers shall be as per the manufacturer recommended designated grounding points for GIS equipment. Main GIS grounding mat shall be buried at the level of station grounding mat. It shall be made up of same conductor as that of station grounding mat. The spacing of main GIS grounding mat for different voltage levels of GIS shall be as per attached Typical Drawing.

1.2. High Frequency Grounding of GIS equipment: Dedicated copper grounding mesh with specified spacing and cross-section shall be provided at the top of GIS building finished floor level. This dedicated copper grounding mesh shall be spread-over, beneath complete GIS switchgears installation and extended up to 500 mm away in all direction from GIS switchgears installation. This dedicated copper grounding mesh shall be directly connected to the GIS enclosures (min. at two distant points in each phase/bay) and to the risers directly coming from GIS grounding mat (min. at two distant locations per phase/bay) with the shortest path to the connection point. All Crossing of copper grounding mesh shall be suitably clamped/welded together. Bolted joint at crossings is not allowed, further this copper grounding mesh shall be clamped adequately to the floor at suitable locations. At the jointing of two different metals the joint shall be made using requisite bi-metallic jointer. This dedicated copper grounding mesh is laid at the top of GIS floor and shall also be connected with dedicated grounding rod electrodes provided at a regular interval of not more than 12 meters around periphery of GIS building. This copper grounding mesh shall be laid after the GIS bays are place on the floor and shall be suitably covered with Non-Electrostatic rubber mats to avoid damage to mesh and to avoid hinderance in regular operation of equipment. The Spacing, conductor detail and cross-section of copper grounding mesh shall be as per attached Typical Drawing.

Typical Drawing No, Standard/GIS/GROUNDING/01 for above said grounding recommendation is part of this document.

DESCRIPTION OF GIS BAY MODULE & EQUIPMENTS

765kV Gas Insulated Switchgear (One & half breaker Scheme)	2
420kV Gas Insulated Switchgear (One & half breaker Scheme)	9
420 kV Gas Insulated Switchgear (Double Main Busbar Scheme)	15
245 kV Gas Insulated Switchgear (Double Main Busbar Scheme)	21
145 kV Gas Insulated Switchgear (Double Main Busbar Scheme)	24
Gas Insulated Outdoor Bus Duct (GIB):.....	27
Gas Insulated SF6 to Air Termination:	27
Gas Insulated SF6 to Oil Termination:	27
Gas Insulated SF6 to Cable Termination:	28
Gas Insulated Surge Arrester:.....	28

765kV Gas Insulated Switchgear (One & half breaker Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type & configuration of different GIS modules shall be as specified below:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.
- ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 1-phase Potential Transformers.
- v. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- vi. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece (interface) module for both the buses shall be in one alignment.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

- vii. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.
- viii. Local Control Cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- iii. Extension piece (Interface) module, as required to extend existing bus so as to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended .
- iv. End Piece (Interface) modules with isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece (interface) module for both the buses shall be in one alignment.

- v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers, 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. One (1) number 3-phase, single pole, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers single phase, SF6 ducts inside GIS hall (up to the outer edge of the wall of GIS Hall).
- viii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc., as required.
- ix. Local Control Cubicle.

'#' As per BPS

iv) GIS Tie Bay module:

SF6 gas-insulated metal enclosed Tie bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vii. Local Control Cubicle.

'#' As per BPS

v) GIS ICT Bay module:

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers 1-phase, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- xi. Local Control cubicle.

vi) GIS Bus Reactor Bay module:

SF6 gas insulated metal enclosed Bus Reactor Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.

- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Bus reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- xi. Local Control cubicle.

vii) GIS Switchable Line Reactor Bay module:

SF6 gas insulated metal enclosed Switchable Line reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. One (1) number 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.
- iii. One (1) number 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Line reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- vii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- viii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- ix. Local Control cubicle.

viii) GIS Line Reactor Bay module:

SF6 gas insulated metal enclosed Non-Switchable Line reactor bay module, each set comprising of the following:

- i. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- ii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Line reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- vi. Local Control cubicle (if required separately).

ix) GIS Auxiliary Bus module for Spare ICT Connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iii. One (1) number single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

x) GIS Auxiliary Bus module Extension for Spare ICT connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

- iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

xi) GIS Auxiliary Bus module for Spare Reactor Connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for Reactor bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of Reactor with all Reactor Bay Modules through GIS Duct and provision of extension for future Reactors.
- ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iii. One (1) number single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- vi. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

xii) GIS Auxiliary Bus module Extension for Spare Reactor connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for Reactor bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of Reactor with all Reactor Bay Modules through GIS Duct and provision of extension for future Reactors.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

xiii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionalizer Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) Numbers single phase, SF6 ducts for interconnection of above mentioned elements.
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- viii. Local Control Cubicle

420kV Gas Insulated Switchgear (One & half breaker Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.
- ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers 1-phase Potential Transformers complete with manual operated isolating Switch/device.
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

- vi. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.
- vii. Local Control Cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) modules with the isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.
- v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers, 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. One (1) number 3-phase, single pole, high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers single phase, SF6 ducts inside GIS hall (up to the outer edge of the wall of GIS Hall).
- viii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc., as required.
- ix. Local Control Cubicle.

'#' As per BPS

iv) GIS Tie Bay module:

SF6 gas-insulated metal enclosed Tie Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on other side of circuit breaker
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vii. Local Control Cubicle.

'#' As per BPS

v) GIS ICT bay module (For 400kV side of 765/400kV ICT):

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers 1-phase, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- ix. Three (3) numbers single phase SF6, ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- xi. Local Control cubicle.

vi) GIS Auxiliary Bus module for Spare ICT Connection (For 400kV side of 765/400kV ICT):

Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iii. One (1) number, single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vii) GIS Auxiliary Bus module Extension for Spare ICT connection (For 400kV side of 765/400kV ICT):

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

viii) GIS ICT bay module (For 400kV HV side of 400/220kV ICT):

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- viii. Local Control Cubicle.

ix) GIS Bus reactor bay module:

SF6 gas insulated metal enclosed Bus reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.
- viii. Local Control cubicle.

x) GIS Line Reactor Bay module:

SF6 gas insulated metal enclosed Line reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- ii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.
- v. Local Control cubicle (if required separately).

xi) GIS Switchable Line reactor bay module:

SF6 gas insulated metal enclosed switchable Line reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

- vi. Local Control cubicle.

Note: Quantity of “3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms” and “3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms” shall be Two (2) nos. in case of direct connection of Line Reactor with GIS.

xii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionalizer Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts for interconnection of above mentioned elements.
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- viii. Local Control Cubicle

420 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.
- ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers 1-phase Potential Transformers complete with manual operated isolating Switch/device.
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.
- v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

- vi. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.
- vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing bus so as to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) modules with the isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

- v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.
- ii Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi One (1) number 3-phase, single pole, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.
- vii Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall)
- viii Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- ix Local Control Cubicle.

‘#’ As per BPS

iv) GIS ICT bay module (For 400kV side of 765/400kV ICT):

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.
- vii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

- viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.
- ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- xi. Local Control cubicle.

**v) GIS Auxiliary Bus module for Spare ICT Connection (For 400kV side of 765/400kV ICT):
Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:**

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iii. One (1) number, single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link on both side of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi) GIS Auxiliary Bus module Extension for Spare ICT connection (For 400kV side of 765/400kV ICT):

Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

- i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

- iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

vii) GIS ICT bay module (For 400kV HV side of 400/220kV ICT):

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- viii. Local Control Cubicle.

viii) GIS Bus Coupler Bay module:

SF6 gas-insulated metal enclosed Bus Coupler Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vii. Local Control Cubicle.

ix) GIS Bus Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- viii. Local Control Cubicle.

x) GIS Line reactor bay module:

SF6 gas insulated metal enclosed Line reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- ii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.
- v. Local Control cubicle (if required separately).

xi) GIS Switchable Line reactor bay module:

SF6 gas insulated metal enclosed switchable Line reactor bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.
- ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

- iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
- v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.
- vi. Local Control cubicle.

xii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionalizer Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.
- iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.
- iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. Three (3) numbers single phase, SF6 ducts for interconnection of above mentioned elements.
- vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.
- viii. Local Control Cubicle

245 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

3-single (isolated) phase/Three phase enclosed, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Three (3) numbers single(isolated) phase / One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.
- ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- iii. Three (3) numbers 1-phase Potential Transformers, complete with manual operated isolating Switch/device.
- iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.
- v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

- vi. Three (3) numbers single(isolated) phase / One (1) number three phase, SF6 ducts (as required) inside GIS hall
- vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of 3-single (isolated) phase/Three phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) modules with the isolating test link for Future extension (on one side) of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

- v. Three (3) numbers single(isolated) phase / One (1) number three phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v One (1) number 3-phase, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.
- vi Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall)
- vii Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- viii Local Control Cubicle.

iv) GIS ICT bay module:

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vii. Local Control Cubicle.

v) GIS Bus Coupler Bay module:

SF6 gas-insulated metal enclosed Bus Coupler Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vi. Local Control Cubicle.

vi) GIS Bus Section Bay module:

SF6 gas-insulated metal enclosed Bus Section Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Three (3) numbers single phase(isolated) / One (1) number three phase , SF6 ducts for interconnection of above mentioned elements.
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- vii. Local Control Cubicle.

vii) GIS Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

- vii. Local Control Cubicle.

145 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Sets of three phase enclosed, SF6 gas-insulated metal enclosed Bus Bar modules, each set comprising of the following:

- i. One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double main bus bar system.
- ii. One (1) number 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iii. One (1) number 3-phase inductive potential transformers, complete with manual operated isolating Switch/device.
- iv. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

- vi. One (1) number three phase, SF6 ducts (as required) inside GIS hall.
- vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.
- ii. Gas monitoring devices, barriers, pressure switches, support structure etc. as required.
- iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- iv. End Piece (Interface) modules with the isolating test link for Future extension (on one side) of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.
- v. One (1) number three phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.
- iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. One (1) number 3-phase, high speed fault making grounding switch, complete with group operated manual and motor driven operating mechanisms.
- vi. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vii. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- viii. Local Bay control cubicle.

iv) GIS ICT bay module:

SF6 gas-insulated metal enclosed ICT feeder bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 3-phase, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- v. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- vii. Local Bay control cubicle.

v) GIS Bus Coupler Bay Module:

SF6 gas-insulated metal enclosed Bus-Coupler Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

- iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- vi. Local Bay Control Cubicle.

vi) GIS Bus Section Bay Module:

SF6 gas-insulated metal enclosed Bus Section Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. One (1) number 3-phase, SF6 ducts for interconnection of above mentioned elements.
- vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- vii. Local Bay Control Cubicle.

vii) GIS Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

- i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
- ii. Three (3) numbers 1-phase, 4-core, multi ratio, current transformers.
- iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.
- iv. Three (3) numbers 3-phase, group operated safety grounding switches complete with manual and motor driven operating mechanisms.
- v. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).
- vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.
- vii. Local Bay control cubicle.

Gas Insulated Outdoor Bus Duct (GIB):**(i) 765kV & 420kV GIB:**

For making connections with outdoor overhead lines/Transformer/Reactor, Single Phase enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch, UHF PD Sensor etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

(ii) 245kV GIB:

For making connections with outdoor overhead lines/Transformer/Reactor, **Single/Three Phase** enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch, UHF PD Sensor etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

(iii) 145kV GIB:

For making connections with overhead lines/Transformer/Reactor, Three Phase enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/ SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

The GIB duct length shall be optimized further meeting present & future bay requirements without affecting the switchyard arrangement, bay orientation and any of the specified functional requirements.

Gas Insulated SF6 to Air Termination:

For making connections with overhead lines/Transformer/Reactor, SF6 to Air bushing including accessories shall be as specified below:

- (i) **For 765kV/420/245/145kV:** SF6 to air bushings along with terminal connectors & support structure etc. as required for outdoor connections to connect GIS with overhead line/Transformer/Reactor.

Gas Insulated SF6 to Oil Termination:

For making direct connections with Transformer/Reactor, GIS Interface module along with associated active parts to facilitate the direct connection of GIS duct with Transformer/Reactor is under the present scope of subject package which is as specified below:

- (i) **For 765kV/420/245/145kV:** 1-phase Gas insulated interface module along with associated active parts to facilitate the direct inter-connection of GIS duct with the Transformer/Reactor.

Supply of SF6 to Oil bushing is in the scope of Transformer/Reactor Manufacturer. The limits of supply of the GIS switchgear manufacturer and transformer manufacturer shall be as per IEC 62271-211. The drawings/details of SF6 to Oil bushing along with other required data of Transformer/Reactor shall be provided during detailed engineering.

Gas Insulated SF6 to Cable Termination:

For making connections of GIS switchgear/duct with XLPE Cable, GIS Interface module along with associated active parts to facilitate the connection of GIS switchgear/duct with XLPE Cable as per IEC-62271-209 is under the present scope of subject package which is as specified below:

- (i) **For 245kV:** 1-phase / 3-Phase Gas Insulated SF6 to cable connection module along with associated active parts to interconnect GIS with XLPE Cable. The Support Structure required to support the XLPE cable upto the GIS termination point is also in the present scope of subject package.
- (ii) **For 145kV:** 3-Phase Gas Insulated SF6 to cable connection module along with associated active parts to interconnect GIS with XLPE Cable. The Support Structure required to support the XLPE cable upto the GIS termination point is also in the present scope of subject package.

Supply of XLPE Cable along with termination kit is in the scope of Cable Manufacturer. The limits of supply of the GIS switchgear manufacturer and Cable termination shall be as per IEC 62271-209. The drawings/details of XLPE cable along with termination kit shall be provided during detailed engineering.

Gas Insulated Surge Arrester:

- (i) **For 765kV/420kV :** 1-phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)
- (ii) **For 245kV:** 1-phase/3-Phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)
- (iii) **For 145kV:** 3-phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)

SECTION: STRUCTURE

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SECTION: STRUCTURES

1.0 GENERAL

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanised steel structures for towers, beams, lightning masts and equipment support structures. If specified in section – Project, design of steel structure shall also be in the scope of contractor. The structures shall be of pipe type or lattice type as per Bid Proposa Sheet. Lattice structures shall be fabricated from structural steel conforming to IS: 2062 (latest). All pipe structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806.

Line diagrams of Towers, beams, Lightning masts, equipment support structures are enclosed with the tender document. The fabrication drawings along with BOMs for these structures shall be provided to the successful bidder after the award. However structure, which are to be designed at detailed engineering stage by the employer, only line diagram shall be provided by POWERGRID and fabrication drawing shall be prepared by the Contractor. Support structure for circuit breaker shall be designed by the Manufacturer. Any other structure necessary to suit the layout for a particular substation to complete the work in all respect shall be designed by the employer / contractor at detailed Engineering stage.

Equipment support structure standardization has been carried out by the employer with the provision of stool to facilitate interchangeability of equipments at a later stage. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m. Zinc coating for costal areas, if defined in section – Project shall not be less than 900gm/sq.m

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box,

surge counter, etc. in the standard structure fabrication drawings. Nothing extra shall be payable or recoverable from the contractor on account of modification in support structures.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES (To be referred only for structures to be designed by the Contractor)

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875,Parts I to V.

2.2 For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.

2.3 Minimum thickness of galvanized tower member shall be as follows:

Members	Minimum thickness (mm)
Leg members, Ground wire	
Peak members/Main members	5
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 Step Bolts

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

2.8 Design Criteria

- a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63kA or as applicable. IEC-60865 may be followed for evaluation of short circuit forces.
- b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered for the design of switchyard structures.
- c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.
- d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 9 metric tonnes per phase for 765kV, 4 metric tonnes per phase for 400kV, 2 metric tonnes per phase for 220kV and 1 metric tonne per phase for 132 kV or as per requirements whichever is higher . The distance between terminal gantry and dead end tower shall be taken as 200 metres for 765/400/220kV and 100m for 132KV. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.
- e) The beams shall be connected with towers/ columns by bolted joints.
- f) All Pipe support structures used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS: 1161 read in conjunction with IS: 806.
- g) If luminaries are proposed to be fixed on gantries, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.
- h) Foundation bolts shall be designed for the loads for which the structures are designed.

- i) Height of Lightning masts shall be as per approved structure layout and designed for diagonal wind condition. Lightning masts shall be provided with platforms for mounting lighting fixtures and a structural steel ladder within its base up to the level of platform. The ladder shall be provided with protection rings. The platforms shall also have protection railing. The details of lighting fixtures would be as per the approved drawings.

3.0 DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

3.1 Structures, for which line diagram has already been provided along with tender documents, fabrication drawings (structure assembly drawing) along with Bill of Material shall be provided to the successful bidder after award based on which structures shall be supplied. Fabrication drawings issued to the contractor for any project shall be valid for other projects also if wind speed of the area is same. These drawings are also available on the POWERGRID web site and can be downloaded from the web site. Hard copies, if needed, can be obtained from employer. These drawings shall be good for fabrication and inspection of steel structures for any substation. Release for construction stamp for particular substation is not required. Replacing MS section with higher section or replacing MS section with HT section of same size due to non availability of particular section shall not require employer's approval and this can be done without any additional financial implication to the employer.

3.2 STRUCTURES DESIGNED DURING DETAILED ENGINEERING:

3.2.1 In case design of structure is to be done by employer, only line diagram of the structure shall be provided to the contractor and fabrication drawing shall be prepared by contractor based on line diagram and submitted for approval.

3.2.2 In case design of structure is covered in the scope of contract, the contractor shall submit design alongwith line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employers' approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.

3.2.3 The fabrication drawings to be prepared and furnished by the Contractor shall be based on line diagram provided by employer or the design approved by the employer. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.

3.3 Such approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.0 FABRICATION AND ERECTION

4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

4.3 Sample towers, beams, lightning masts and equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.

4.4 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification, if any, required during erection shall be done at site with the approval of Engineer – in- charge.

5.0 BOLTING

- i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- ii) In case of fasteners, the galvanizing shall conform to IS-1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS-1573.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be

according to IS:813. Welding shall be carried out in accordance with IS:816.

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

7.4 All foundation bolts shall be provided with two no. standard nuts of class 5 confirming to IS:1363/1367/6639, one check nut of class 4 confirming to IS:1364, one ancore plate at the bottom of foundation bolt and one plain washer.

7.5 All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062/ SAE:1018.

8.0 STABILITY OF STRUCTURE

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

10.0 GALVANISING

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4579. Purity of zinc to be used shall be 99.95% as per IS:209.

11.0 TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying

zinc rich primer and two coats of enamel paint to the satisfaction the employer before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

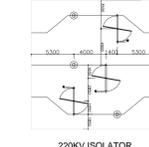
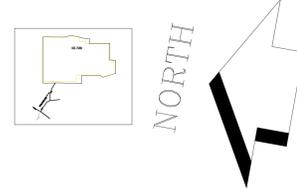
14.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.

15.0 All tests mentioned in standard field quality plans shall have to be carried out and conformity of materials and workmanship shall be ascertained.

DRG. NO. TB202447-1002655-SC3640-765KV-EL-LO

ID	East M	North M
A	702952.940	2598159.930
B	703664.540	2598258.490
C	703743.690	2597933.400
D	703743.690	2597733.520
E	703741.960	2597737.390
F	703729.010	2597626.920
G	703734.350	2597546.710
H	703706.660	2597514.030
I	703706.520	2597186.780
J	703449.280	2597181.520
K	703458.730	2597093.030
L	703255.900	2597064.370
M	703170.400	2597253.660
N	703150.130	2597583.320
O	703150.240	2597564.050
P	703031.280	2597564.050
Q	702987.910	2597929.310



220KV ISOLATOR

BILL OF QTY. FOR 765KV MAIN EQUIPMENTS:

SLNO.	DESCRIPTION	RATING	A.C. W/RTING	SLD QTY (NO.)	MGA QTY (NO.)	SYMBOL
1	50 MVA (1 PH) AUTOTRANSFORMER	765KV	50 KA FOR 1 S	07	07	⊕
2	MANUAL LINE REACTOR (1 PH)	765KV	50 KA FOR 1 S	07	07	⊕
3	110KVAR BUS REACTOR (1 PH)	765KV	50 KA FOR 1 S	07	07	⊕
4	SPR CIRCUIT BREAKER WITH C/W/OUT CSD (3 PH)	765KV/315KA	50 KA FOR 1 S	04	06	⊕
5	SPR CIRCUIT BREAKER WITHOUT C/W/OUT CSD (3 PH)	765KV/315KA	50 KA FOR 1 S	08	06	⊕
6	SPR CB WITH/OUT C/W/OUT CSD (3 PH) FOR 1 PH (W/OUT CSD)	765KV/315KA	50 KA FOR 1 S	02	02	⊕
7	SPR CB WITHOUT C/W/OUT CSD (3 PH)	765KV/315KA	50 KA FOR 1 S	02	02	⊕
8	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	765KV/315KA	50 KA FOR 1 S	18	18	⊕
9	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	765KV/315KA	50 KA FOR 1 S	10	10	⊕
10	ISOLATOR WITH ONE E/S (1 PH) VERTICAL KNEE TYPE	765KV/315KA	50 KA FOR 1 S	21	21	⊕
11	ISOLATOR WITHOUT E/S (1 PH) VERTICAL KNEE TYPE	765KV/315KA	50 KA FOR 1 S	33	33	⊕
12	CURRENT TRANSFORMER (1 PH) WITH 100% EXTENDED CURRENT RATING TYPE	300KA	50 KA FOR 1 S	36	36	⊕
13	CVT (1 PH)	800KV	NA	18	18	⊕
14	SURGE ARRESTER (1 PH)	624 KV	NA	33	33	⊕
15	WAVE TRAP (1 PH) PEDESTAL TYPE	144K/315KA	50 KA FOR 1 S	08	08	⊕
16	765KV SPT	765KV		61	78	⊕
17	765KV SPT (SPARE BUS)	765KV		07	07	⊕

400KV MAIN EQUIPMENTS

SLNO.	DESCRIPTION	RATING	A.C. W/RTING	SLD QTY (NO.)	MGA QTY (NO.)	SYMBOL
1	SPR REACTOR (3 PH)	400KV	40 KA FOR 1 S	1	1	⊕
2	SPR CIRCUIT BREAKER WITHOUT C/W/OUT CSD (3 PH) WITH 100% EXTENDED CURRENT RATING TYPE	400KV	40 KA FOR 1 S	6	6	⊕
3	SPR CIRCUIT BREAKER WITHOUT C/W/OUT CSD (3 PH) WITH 100% EXTENDED CURRENT RATING TYPE	400KV	40 KA FOR 1 S	6	6	⊕
4	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	400KV	40 KA FOR 1 S	2	2	⊕
5	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	400KV	40 KA FOR 1 S	7	7	⊕
6	ISOLATOR WITH ONE E/S (1 PH) VERTICAL KNEE TYPE	400KV	40 KA FOR 1 S	5	5	⊕
7	CURRENT TRANSFORMER (1 PH) WITH 100% EXTENDED CURRENT RATING TYPE	300KA	40 KA FOR 1 S	48	48	⊕
8	SURGE ARRESTER (1 PH)	336 KV	NA	28	28	⊕
9	WAVE TRAP (1 PH) PEDESTAL TYPE	144K/400KV	40 KA FOR 1 S	2	2	⊕
10	CVT (1 PH)	400KV	400KV	18	18	⊕
11	UNCONTROLLED SWITCHING DEVICE	400KV	400KV	18	18	⊕
12	WAVE TRAP (1 PH) PEDESTAL TYPE	144K/400KV	40 KA FOR 1 S	8	8	⊕
13	ARRESTOR (FOR WAVE TRAP)	24	24	24	24	⊕
14	ARRESTOR	24	24	24	24	⊕
15	765KV SPT (FOR 400 KV) - LAST ITEM	765KV		07	07	⊕

220KV EQUIPMENTS (SHIELD ROOMS)

ITEM NO.	DESCRIPTION	SYMBOL	SLD QTY (NO.)	MGA QTY (NO.)
1	220KV 125KA 40KA/1% CIRCUIT BREAKER (3-PH) WITH SUPPORT STRUCTURE (BY SUPPLIER)	⊕	6	6
2	220KV 125KA 40KA/1% HOB ISOLATOR WITH 12.5% (3-PH)	⊕	6	6
3	220KV 125KA 40KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
4	220KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITH 12.5% (3-PH)	⊕	12	12
5	220KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
6	220KV 125KA 120KA/1% HOB ISOLATOR WITH 12.5% (3-PH) (BY SUPPLIER)	⊕	2	2
7	220KV 125KA 120KA/1% CURRENT TRANSFORMER (1-PH)	⊕	18	18
8	220KV 125KA 120KA/1% CURRENT TRANSFORMER (1-PH)	⊕	3	3
9	220KV 125KA 120KA/1% CURRENT TRANSFORMER (1-PH)	⊕	12	12
10	220KV 125KA 120KA/1% SURGE ARRESTER (1-PH)	⊕	3	3
11	220KV SPT	⊕	18	18

132KV EQUIPMENTS

ITEM NO.	DESCRIPTION	SYMBOL	SLD QTY (NO.)	MGA QTY (NO.)
1	132KV 125KA 40KA/1% CIRCUIT BREAKER (3-PH) WITH SUPPORT STRUCTURE	⊕	6	6
2	132KV 125KA 40KA/1% HOB ISOLATOR WITH 12.5% (3-PH)	⊕	6	6
3	132KV 125KA 40KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
4	132KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITH 12.5% (3-PH)	⊕	12	12
5	132KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
6	132KV SURGE ARRESTER (1-PH)	⊕	3	3

SYSTEM PARAMETERS

Sl. No.	DESCRIPTION OF PARAMETERS	220KV System	400KV System	765KV System
1	SYSTEM OPERATING VOLTAGE (KVMS)	220KV	400KV	765KV
2	MAXIMUM VOLTAGE OF THE SYSTEM (KVMS)	245KV	450KV	800KV
3	RATED FREQUENCY	50Hz	50Hz	50Hz
4	NO. OF PHASES	3	3	3
5	BAY INSULATION LEVELS			
6	IMPULSE WITHSTAND VOLTAGE FOR TRANSFORMERS AND REACTORS FOR OTHER EQUIPMENT FOR PENULTIMATE BAY	410KVp 410KVp 410KVp	412KVp 412KVp 412KVp	210KVp 110KVp 110KVp
7	ONE MINUTE POWER FREQUENCY OVER VOLTAGE WITHSTAND VOLTAGE (KVMS)	405KV	405KV	675KV
8	MAX. RATED INSULATING VOLTAGE FOR FREQUENCY BETWEEN 0.5 MHZ AND 1 MHZ	100KV at 156KV rms	100KV at 156KV rms	220KV at 306KV rms
9	MINIMUM CREEPAGE DISTANCE FOR INSULATOR BENCH FOR OTHER EQUIPMENT	3955 mm 4185 mm	13000 mm 15000 mm	24800 mm 20000 mm
10	MINIMUM CLEARANCES			
11	PHASE TO PHASE	2100 mm	4300 mm	7600 mm
12	PHASE TO EARTH	2100 mm	3300 mm	4900 mm
13	SECTIONAL CLEARANCES	5000 mm	6000 mm	10000 mm
14	RATED SHORT CIRCUIT CURRENT	50 KA for 1 sec	63KA for 1 sec	56KA for 1 sec
15	SYSTEM NEUTRAL EARTHING	Effectively earthed	Effectively earthed	Effectively earthed
16	COEFFICIENT OF NEUTRAL VOLTAGE	NA	30KV	50KV
17	RATED AMBIENT TEMPERATURE	50 Deg. C	50 Deg. C	50 Deg. C

BILL OF QTY. FOR 132KV SUPPLY

SL. NO.	DESCRIPTION	SYMBOL	SLD QTY (NO.)	MGA QTY (NO.)
1	132KV 125KA 40KA/1% CIRCUIT BREAKER (3-PH) WITH SUPPORT STRUCTURE	⊕	6	6
2	132KV 125KA 40KA/1% HOB ISOLATOR WITH 12.5% (3-PH)	⊕	6	6
3	132KV 125KA 40KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
4	132KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITH 12.5% (3-PH)	⊕	12	12
5	132KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	⊕	3	3
6	132KV SURGE ARRESTER (1-PH)	⊕	3	3

REACTOR AREA 132 & 33KV EQUIPMENTS:

Sl. No.	DESCRIPTION	RATING	SLD QTY (NO.)	MGA QTY (NO.)
1	33KV 125KA 40KA/1% CIRCUIT BREAKER (3-PH) WITH SUPPORT STRUCTURE	33KV	3	3
2	33KV 125KA 40KA/1% HOB ISOLATOR WITH 12.5% (3-PH)	33KV	3	3
3	33KV 125KA 40KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	33KV	1.5	1.5
4	33KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITH 12.5% (3-PH)	33KV	4.5	4.5
5	33KV 125KA 120KA/1% HOB TANDEN ISOLATOR WITHOUT E/S (3-PH)	33KV	1.5	1.5
6	33KV SURGE ARRESTER (1-PH)	33KV	1.5	1.5



132KV/33KV ISOLATOR

LOCUS OF THE 132KV EQUIPMENT SHALL BE FULLY MAINTAINED BY THE USER OF THIS DRAWING.

THIS IS A 2D FIRST ANGLE PROJECTION DRAWING. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.

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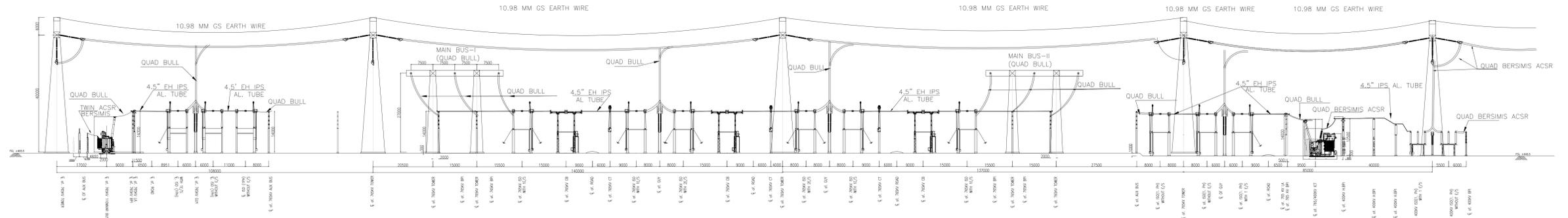
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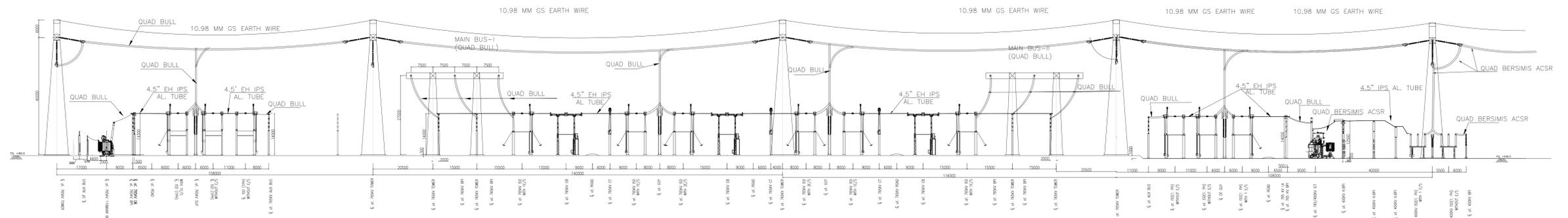
SIGN. AND DATE

NDA NO.: COT/VA/DOA/023/2256/NOA-124-1142402 & COT/VA/DOA/023/2256/NOA-124-1142402
 NAME OF CUSTOMER: RAJASTHAN IV HV POWER TRANSMISSION LIMITED
 NAME OF CONSULTANT: POWERGRID CORPORATION OF INDIA LIMITED
 NAME OF PROJECT: 765KV AS Pkg 02-47T for Establishment of 765/400/220/132KV Busbar Substation (New) including 1x132KV/400KV (3-Ph) Bus Reactor.
 DISTRIBUTION OF PRINTS:
 1. 10/18/24 (DESIGN)
 2. 10/18/24 (CHECK)
 3. 10/18/24 (APPROVAL)
 4. 10/18/24 (ISSUE)
 5. 10/18/24 (REVISION)
 6. 10/18/24 (CANCELLATION)
 7. 10/18/24 (OTHER)
 8. 10/18/24 (TOTAL)
 9. 10/18/24 (REVISIONS)
 10. 10/18/24 (TOTAL)
 11. 10/18/24 (TOTAL)
 12. 10/18/24 (TOTAL)
 13. 10/18/24 (TOTAL)
 14. 10/18/24 (TOTAL)
 15. 10/18/24 (TOTAL)
 16. 10/18/24 (TOTAL)
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 19. 10/18/24 (TOTAL)
 20. 10/18/24 (TOTAL)

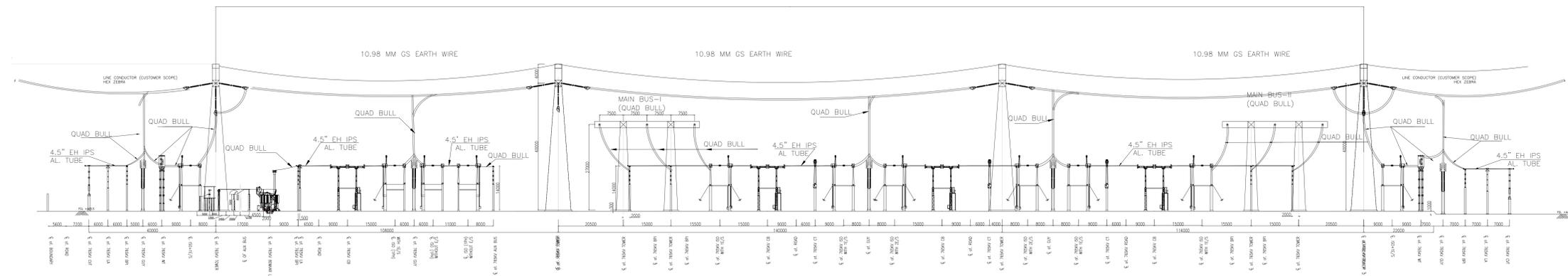
DRG. NO. TB202447-1002655-SC3640-765KV-EL-LO



SECTION 7C-7C (765KV BUS REACTOR-TIE-765KV ICT DIA.4)



SECTION 7B-7B (765KV BUS REACTOR-TIE-765KV ICT DIA.3)



SECTION 7A-7A (765KV LINE-1 WITH REACTOR-TIE-LINE.3)

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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

NDA NO.: CCTWASD00A06231225NDA-124-11423402 A CCTWASD00A06231225NDA-124-11423402 NAME OF CUSTOMER: RAJASTHAN IV HV POWER TRANSMISSION LIMITED NAME OF CONSULTANT: POWERGRID CORPORATION OF INDIA LIMITED NAME OF PROJECT: 765KV ASB Pkg SE-477 for Establishment of 765/400/220 /230KV Barmer Substation (New) including 1x1500MVA (3-Ph) Bus Reactor	
DATE: 18/08/2024 DRAWING NO.: 765KV ASB Pkg SE-477-1002655-SC3640-765KV-EL-LO SHEET NO.: 01 OF 01	PROJECT: RAJASTHAN IV HV POWER TRANSMISSION LIMITED SUBPROJECT: 765KV ASB Pkg SE-477 for Establishment of 765/400/220 /230KV Barmer Substation (New) including 1x1500MVA (3-Ph) Bus Reactor DRAWING NO.: 765KV ASB Pkg SE-477-1002655-SC3640-765KV-EL-LO SHEET NO.: 01 OF 01
DESIGNED BY: [Signature] CHECKED BY: [Signature] APPROVED BY: [Signature]	DATE: 18/08/2024 SCALE: AS SHOWN PROJECT: RAJASTHAN IV HV POWER TRANSMISSION LIMITED SUBPROJECT: 765KV ASB Pkg SE-477 for Establishment of 765/400/220 /230KV Barmer Substation (New) including 1x1500MVA (3-Ph) Bus Reactor DRAWING NO.: 765KV ASB Pkg SE-477-1002655-SC3640-765KV-EL-LO SHEET NO.: 01 OF 01

